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DNA 2725I
JULY 1, 1971
3SR-648

WAVE PROPAGATION IN POROUS GEOLOGIC COMPOSITES

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SYSTEMS, SCIENCE AND SOFTWARE
LA JOLLA, CALIFORNIA 92037

CONTRACT NO. DASA 01-69-C-0159(P00002)

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DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)* Systems, Science and Software Post Office Box 1620 La Jolla, California 92037	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE
Wave Propagation in Porous Geologic Composites

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*
Formal Report

5. AUTHOR(S) *(First name, middle initial, last name)*
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6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
July 1, 1971	339	60

8a. CONTRACT OR GRANT NO. DASA 01-69-C-0159(P002) b. PROJECT NO. ARPA Order No. 1438 c. Program Code No. 9F10 d.	9a. ORIGINATOR'S REPORT NUMBER(S) 3SR-648 9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*

10. DISTRIBUTION STATEMENT

Approved for public release; distribution unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	Advanced Research Projects Agency

13. ABSTRACT

Predictive models for calculating stress wave effects in a geologic medium are developed from the viewpoint that the medium is a composite consisting of the rock matrix and pores that may be only partially filled with water. A representative Nevada Test Site tuff (NTS tuff) is selected in order to be specific in formulating constitutive models for the geologic composite from the equations of state previously developed for its constituents, water and poreless NTS tuff, in an earlier phase of this work. The Theory of Interacting Continua (TINC) framework is used to discuss Hugoniot relations for a composite and previously published models are found to be special cases corresponding to hypotheses on the energy partition and interactive forces between the constituents. A physically realistic equation of state (P*EQ) for completely crushed porous wet tuff is developed which accounts for the material's substructure. The model is based on computer simulation studies of composite configurations. Shock and release states predicted by the P*EQ model are compared with those predicted by an equation of state in which the water and tuff components are considered to be individually shocked to the mutual equilibrium pressure (PEQ) and a composite equation of state based on the assumption of pressure and thermal equilibrium (PTEQ). The energy partition has little effect on the measurable Hugoniot quantities but has a dramatic effect on the release states predicted. Models accounting for the irreversible crushup of porous wet tuff at low pressures are developed in the TINC framework which are formulated in terms of the water and tuff components. Stress pulse calculations are presented using the POROUS code for solving the TINC conservation relations within the mechanical approximation. Extension of the TINC framework to include thermodynamic effects and improved constitutive models for the constituents are discussed and preliminary formulations are presented.

DD FORM 1 NOV 65 1473

UNCLASSIFIED

Security Classification

UNCLASSIFIED
Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Composite Materials						
Stress Waves in Geologic Media						
Water Equation of State						
Underground Explosions						
Nevada Tuff						
Seismic Waves						
Rock and Soil Models						
Porous Media						
Decoupling						

UNCLASSIFIED
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DNA 2725I
JULY 1, 1971

SYSTEMS, SCIENCE AND SOFTWARE

3SR-648

WAVE PROPAGATION IN POROUS GEOLOGIC COMPOSITES

This Work Was Supported By The Advanced Research Projects Agency Under ARPA Order Number 1483, Program Code OF10.

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CONTRACT NO. DASA 01-69-C-0159(P00002)
PROJECT TASK NO. F10; WORK UNIT NO. 01

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Abstract

Predictive models for calculating stress wave effects in a geologic medium are developed from the viewpoint that the medium is a composite consisting of the rock matrix and pores that may be only partially filled with water. A representative Nevada Test Site tuff ($\overline{\text{NTS}}$ tuff) is selected in order to be specific in formulating constitutive models for the geologic composite from the equations of state previously developed for its constituents, water and poreless $\overline{\text{NTS}}$ tuff, in an earlier phase of this work. The Theory of Interacting Continua (TINC) framework is used to discuss Hugoniot relations for a composite and previously published models are found to be special cases corresponding to hypotheses on the energy partition and interactive forces between the constituents. A physically realistic equation of state (P*EQ) for completely crushed porous wet tuff is developed which accounts for the material's substructure. The model is based on computer simulation studies of composite configurations. Shock and release states predicted by the P*EQ model are compared with those predicted by an equation of state in which the water and tuff components are considered to be individually shocked to the mutual equilibrium pressure (PEQ) and a composite equation of state based on the assumption of pressure and thermal equilibrium (PTEQ). The energy partition has little effect on the measurable Hugoniot quantities but has a dramatic effect on the release states predicted. Models accounting for the irreversible crushup of porous wet tuff at low pressures are developed in the TINC framework which are formulated in terms of the water and tuff components. Stress pulse calculations are presented using the POROUS code for solving the TINC conservation relations within the mechanical approximation. Extension of the TINC framework to include thermodynamic effects and improved constitutive models for the constituents are discussed and preliminary formulations are presented.

Foreword

This formal technical report entitled "Wave Propagation in Porous Geologic Composites," is submitted by Systems, Science and Software (S^3) to the Advanced Research Projects Agency (ARPA) and to the Defense Nuclear Agency (DNA). The report presents the results of a second phase of a continuing effort to develop reliable material models to predict the response of geologic media in the pressure regime from 200 kbar down to a few hundred bars. This work, in support of the PRIME ARGUS research program, was accomplished under Contract No. DASA 01-69-C-0159(P002), which was funded by ARPA. Dr. Stanley Ruby was the ARPA Program Manager and Mr. Clifton B. McFarland was the DNA Project Scientist.

Dr. T. David Riney was the S^3 Principal Investigator for this study. The technical results presented in this report represent the work of a number of S^3 staff members in addition to the authors. It is appropriate to list here the contributors to Chapters II through VI:

Chapter II:	S. K. Garg, J. W. Kirsch, J. K. Dienes
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Chapter IV:	C. R. Hastings, C. H. Ebert, S. K. Garg
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Dr. L. W. Morland of the University of East Anglia served as a consultant on this project and made important contributions to the development of the models within the framework of the Theory of Interacting Continua. Dr. J. M. Walsh contributed to the thermodynamic studies. The authors are indebted to Dr. G. D. Anderson for technical review of this report.

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I. INTRODUCTION

A typical geologic medium consists of a rock or soil matrix containing cracks or pores that may be partially filled with water. Even if the matrix material is unchanged, the porosity and the water content will vary with depth and with surface distance and the stress wave propagation characteristics of the medium will vary accordingly. Since it is impractical to perform material properties tests on all possible porosities and degrees of saturation, it is desirable to develop the capability to predict the response of the medium as these quantities are varied.

In the present study the geologic medium is considered to be a composite and a description of its wave propagation characteristics is sought in terms of the behavior of the isolated matrix and water components. The general approach is to construct material models of increasing sophistication from available material properties data and to use analytical and numerical methods to evaluate stress wave phenomena as each additional physical effect is introduced into the model. Nevada tuff was selected as the matrix rock material to be specific, but the basic methods should be applicable to other porous geologic media. The pressure regime considered is from 200 kbar down to a few hundred bars.

In this stress amplitude range the presence of the water in the rock matrix affects the dynamic response of the medium in a number of ways, e.g.,

1. Phase changes in the rock and water components depend on the partition of the available thermal energy between the two components.
2. The irreversible mechanical crushup of the rock matrix will depend on the distribution of the load between the matrix and the water components.

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3. The pressure that the pore water exerts on the rock matrix strongly affects the yield strength and the fracture strength of a rock.

4. The relative motion of the pore water with respect to the matrix produces interaction shear stresses which act as a dissipative mechanism during wave propagation.

The models developed for the geologic composite should describe these known physical effects in terms of the behavior of the water and tuff components. Reference to the detailed microstructure of the composite must be avoided, however, since the models are to be used in continuum type computer codes in which the phenomena of interest are on a much larger geometrical scale.

Computer codes currently employed for ground shock calculations treat a geologic medium as a single continuum so that each incremental volume of the medium has associated a single value of pressure, velocity, etc. This treatment cannot explicitly account for the interaction forces between the matrix and pore fluid constituents (such as 3. and 4.), which involve different values of pressure and velocity for the water and rock components of the geologic composite. Consequently, the Theory of Interacting Continua (TINC) has been adopted to provide a framework general enough to allow explicit treatment of these effects. Since practical calculations will continue to be conducted using single continuum codes, however, the models for effects 1. and 2. have been developed to be compatible with application in single continuum codes.

In Chapter II the basic TINC concepts are introduced and the associated Hugoniot relations are developed which permit an arbitrary partition of the shock energy between the rock and water components. The models presented earlier

in 3SR-267* for the extreme assumptions on the energy partition (PEQ and PTEQ) are special cases. In the PEQ model each component is assumed to independently attain the mutual equilibrium pressure by a single shock process and no heat transfer between components is permitted. In the PTEQ model the components are assumed to be in both thermal and pressure equilibrium behind the shock front. The validity of these extreme assumptions are discussed for both laboratory shock wave experiments and actual field test conditions.

In Chapter III detailed numerical calculations for water and tuff composite laminated configurations are used to develop the P*EQ model based on a more realistic intermediate partition of the shock energy. The tuff is found to reach the equilibrium pressure in a multiple shock sequence, but the water reaches the equilibrium pressure by what is essentially a double-shock process. The equations of state for the isolated water and tuff components, presented in 3SR-267, are used in calculations to compare the predicted shock and release adiabat behavior of wet tuff for the PEQ, PTEQ and P*EQ models. The effect of variations in the degree of saturation of the wet tuff is explicitly treated.

In Chapter IV the irreversible mechanical crushup of dry tuff and partially saturated wet tuff are modeled within the TINC framework. A scheme is outlined for coalescing the low pressure crushup model with the completely crushed reference states computed with one of the alternative (PEQ, PTEQ or P*EQ) equations of state for wet tuff.

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*Here and throughout this document 3SR-267 refers to the report [Ref. 1] describing the results of an earlier phase of this contract.

A 1-D computer code (POROUS) has been developed for computing stress wave effects within the mechanical formulation of TINC. Pulse propagation calculations for saturated and unsaturated tuff are presented in Chapter V for the cases in which relative motion of the water and tuff matrix is described by a simple Darcy diffusion law and the tuff matrix is treated as elastic-perfectly plastic. More realistic treatments for the deviatoric response of the rock component and non-Darcian diffusion are discussed. A tentative procedure to extend the TINC formulation to account for thermodynamic effects is also described. Finally, in Chapter VI, the status of the work is summarized and suggestions are made for the direction of the effort during the next contract period.

II. CONCEPTS FROM THEORY OF INTERACTING CONTINUA

2.1 INTRODUCTION

In 3SR-267 the Theory of Interacting Continua (TINC) was introduced to provide a framework for describing the behavior of a geologic composite in terms of the isolated behavior of its constituent materials. In TINC, it is assumed that every small volume of the composite body is occupied by particles of each constituent $\overset{(\alpha)}{s}$ $(\alpha = 1, \ldots r)$. Furthermore, each constituent $\overset{(\alpha)}{s}$ has a velocity field $\overset{(\alpha)}{\underline{v}}$ $(\underline{x}, t)$ through the composite where $\underline{x}$ denotes the position vector in space (with respect to a fixed Newtonian frame) and t denotes time. The mass of constituent $\overset{(\alpha)}{s}$ per unit volume of composite is called its partial density $\overset{(\alpha)}{\rho}$ $(\underline{x}, t)$, and the total mass per unit volume of composite $\rho(\underline{x}, t)$ is given by

$$\rho = \sum_{\alpha=1}^{r} \overset{(\alpha)}{\rho} \tag{2.1}$$

Similarly the total stress tensor $\underset{\sim}{\sigma}$, associated with a unit area of the composite may be decomposed into partial stresses $\overset{(\alpha)}{\underset{\sim}{\sigma}}$, associated with each component $\overset{(\alpha)}{s}$.

$$\underset{\sim}{\sigma} = \sum_{\alpha=1}^{r} \overset{(\alpha)}{\underset{\sim}{\sigma}} \tag{2.2}$$

General relations expressing conservation of mass, momentum and energy may be written for each $\overset{(\alpha)}{s}$ (see 3SR-267). Here we shall restrict the discussion to plane wave propagation in the x-direction. Assuming that external body forces are absent and that there is no mass transfer between the constituents due to chemical interaction, the conservation relations for $\overset{(\alpha)}{s}$ may be expressed as

$$\frac{\partial \overset{(\alpha)}{\rho}}{\partial t} + \overset{(\alpha)}{v}\frac{\partial \overset{(\alpha)}{\rho}}{\partial x} + \overset{(\alpha)}{\rho}\frac{\partial \overset{(\alpha)}{v}}{\partial x} = 0 \tag{2.3}$$

$$\overset{(\alpha)}{\rho}\left(\frac{\partial \overset{(\alpha)}{v}}{\partial t} + \overset{(\alpha)}{v}\frac{\partial \overset{(\alpha)}{v}}{\partial x}\right) = \rho\,\overset{(\alpha)}{\beta} + \frac{\partial \overset{(\alpha)}{\sigma}_x}{\partial x} \tag{2.4}$$

$$\overset{(\alpha)}{\rho}\left(\frac{\partial \overset{(\alpha)}{E}}{\partial t} + \overset{(\alpha)}{v}\frac{\partial \overset{(\alpha)}{E}}{\partial x}\right) = \overset{(\alpha)}{\sigma}_x\frac{\partial \overset{(\alpha)}{v}}{\partial x} + \rho\,\overset{(\alpha)}{\psi} - \frac{\partial \overset{(\alpha)}{\hat{q}}}{\partial x} \tag{2.5}$$

Here

$\overset{(\alpha)}{v}$ = velocity of material $\overset{(\alpha)}{s}$

$\overset{(\alpha)}{\beta}$ = momentum supply to $\overset{(\alpha)}{s}$ per unit mass of composite due to interaction forces

$\overset{(\alpha)}{\psi}$ = energy supply to $\overset{(\alpha)}{s}$ per unit mass of composite due to interaction forces

$\overset{(\alpha)}{E}$ = internal energy per unit mass of material $\overset{(\alpha)}{s}$

$\overset{(\alpha)}{\hat{q}}$ = heat flux vector into $\overset{(\alpha)}{s}$ from the remaining α-1 constituents

The requirements that the total momentum and energy contributions of the internal material interaction forces be zero may be written as

$$\sum_{\alpha=1}^{r} \rho \overset{(\alpha)}{\beta} = 0 \tag{2.6}$$

$$\sum_{\alpha=1}^{r} \left[\rho \left(\overset{(\alpha)}{\beta} \overset{(\alpha)}{v} + \overset{(\alpha)}{\psi} \right) - \frac{\partial \overset{(\alpha)}{\hat{q}}}{\partial x} \right] = 0 \tag{2.7}$$

For future convenience, we also record here the conservation relations in integral form:

<u>Continuity</u>

$$\int_V \frac{\partial \overset{(\alpha)}{\rho}}{\partial t} \, dV + \int_S \overset{(\alpha)}{\rho} \overset{(\alpha)}{v}_j n_j \, dS = 0 \tag{2.8}$$

<u>Momentum</u>

$$\int_V \frac{\partial}{\partial t} \left(\overset{(\alpha)}{\rho} \overset{(\alpha)}{v}_i \right) dV + \int_S \overset{(\alpha)}{\rho} \overset{(\alpha)}{v}_i \overset{(\alpha)}{v}_j n_j \, dS$$

$$= \int_S \overset{(\alpha)}{\sigma}_{ij} n_j \, dS + \int_V \rho \overset{(\alpha)}{\beta}_i \, dV \tag{2.9}$$

Energy

$$\int_V \frac{\partial}{\partial t}\left[\overset{(\alpha)}{\rho}\left(\overset{(\alpha)}{E} + \frac{1}{2}\overset{(\alpha)}{v_j}\ \overset{(\alpha)}{v_j}\right)\right] dV$$

$$+ \int_S \overset{(\alpha)}{\rho}\left[\overset{(\alpha)}{E} + \frac{1}{2}\overset{(\alpha)}{v_j}\ \overset{(\alpha)}{v_j}\right]\overset{(\alpha)}{v_i}\ n_i\ dS$$

$$= \int_S \overset{(\alpha)}{\sigma_{ij}}\ \overset{(\alpha)}{v_i}\ n_j\ dS - \int_S \overset{(\alpha)}{\hat{q}_j}\ n_j\ dS$$

$$+ \int_V \left\{\rho\ \overset{(\alpha)}{\underline{\beta}} \cdot \overset{(\alpha)}{\underline{v}} + \rho\ \overset{(\alpha)}{\psi}\right\} dV \qquad (2.10)$$

where $\underline{n}$ is the normal in the outward direction to surface S, and $\alpha = 1, 2, \ldots r$.

In writing the above conservation relations in the TINC framework no reference is made to the actual mean volume $\overset{(\alpha)}{n}$ occupied by $\overset{(\alpha)}{s}$ per unit volume of composite. If the interaction terms and constitutive relations for the composite medium are to be expressed in terms of the behavior of the isolated constituents, however, reference must be made to the actual constituents. In 3SR-267 effective densities, $\overset{(\alpha)}{\rho}{}^e$, and effective stress tensors, $\overset{(\alpha)}{\underset{\sim}{\sigma}}{}^e$, were defined in terms of partial densities and partial stresses by the scaled relations:

$$\overset{(\alpha)}{\rho} = \overset{(\alpha)}{n}\ \overset{(\alpha)}{\rho}{}^e \qquad (2.11)$$

$$\overset{(\alpha)}{\underset{\sim}{\sigma}} = \overset{(\alpha)}{n}\ \overset{(\alpha)}{\underset{\sim}{\sigma}}{}^e \qquad (2.12)$$

where

$$\sum_{\alpha=1}^{r} \overset{(\alpha)}{n} = 1 \tag{2.13}$$

In writing these definitions the composite is tacitly assumed to be isotropic so that each plane through the medium intersects the same area fraction of $\overset{(\alpha)}{s}$. Then the area and volume fractions are the same for $\overset{(\alpha)}{s}$ and a single scaling fraction $\overset{(\alpha)}{n}$ occurs in both (2.11) and (2.12)

In the following discussion $\alpha = 1, 2, 3$ will be used to designate tuff (poreless), water, and voids, respectively. Unless otherwise stipulated, however, the discussion in this chapter will pertain only to a fully saturated porous solid $\left(\overset{(1)}{s} \sim \text{solid}, \overset{(2)}{s} \sim \text{water, and } \overset{(3)}{n} = 0\right)$.

The interaction terms occurring in the conservation relations are discussed in Section 2.2. In Section 2.3, we derive the Hugoniot forms for a binary composite. Hugoniot equations derived by Tsou and Chou[2] and Torvik[3] are special cases of these more general forms. The present system of equations may also be specialized to yield PTEQ or PEQ models discussed in 3SR-267. In Section 2.4, we examine the mechanical model in some detail and give numerical results. The question of energy partitioning and the appropriateness of PTEQ or PEQ models for specific applications is discussed in Section 2.5.

2.2 INTERACTION TERMS

The momentum interaction term $\rho\overset{(\alpha)}{\beta}$ incorporates both dilatation and shear (diffusive) interactions. It was incorrectly assumed in 3SR-267 that $\rho\overset{(\alpha)}{\beta}$ is a purely diffusive force. The assumption that $\rho\overset{(\alpha)}{\beta}$ is a purely diffusive force is correct only in the case of small deformations. For a binary mixture, it is convenient to rewrite Eq. (2.6) as:

$$\rho\overset{(1)}{\beta} = -\rho\overset{(2)}{\beta} = \rho\beta \text{ (say)} \tag{2.14}$$

To investigate the inter-relationship between the dilatation and shear components of $\rho\beta$ it is convenient to consider a laminated structure, Fig. 2.1. The results obtained here are, however, not restricted to a laminated structure, but are valid whenever the assumptions of TINC hold. From the symmetry of the structure, it is obvious that we need to consider only the material bounded by the dashed lines (Fig. 2.1b). For the binary mixture, we can introduce

$$\overset{(1)}{n} = n$$

and

$$\overset{(2)}{n} = 1 - \overset{(1)}{n} = 1 - n. \tag{2.15}$$

The second material exerts normal (N) and tangential $(\rho_0\eta)$ stresses on the first material (Fig. 2.1c). The first material in turn exerts equal and opposite forces on the second material. The component along the x-direction is clearly

$$\rho\beta = N\frac{\partial n}{\partial x} + \rho_0\eta \tag{2.16}$$

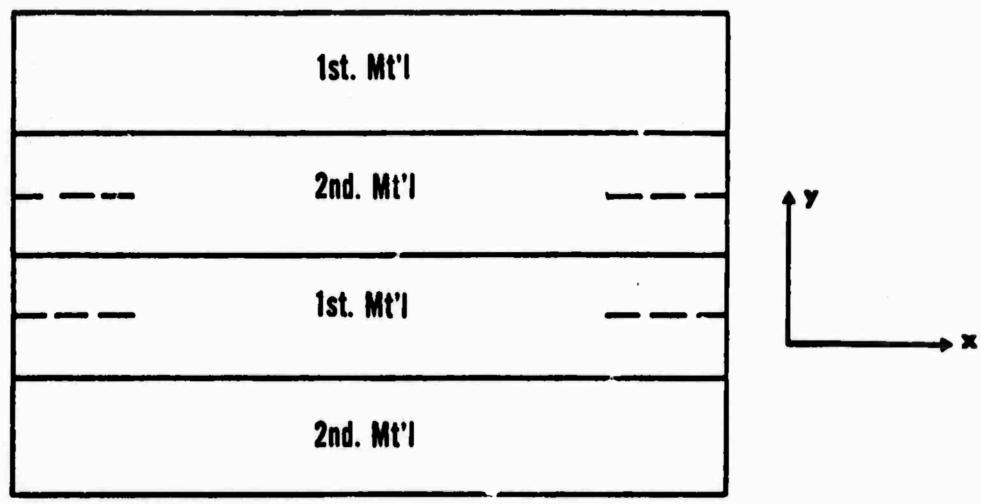

Fig. 2.1a

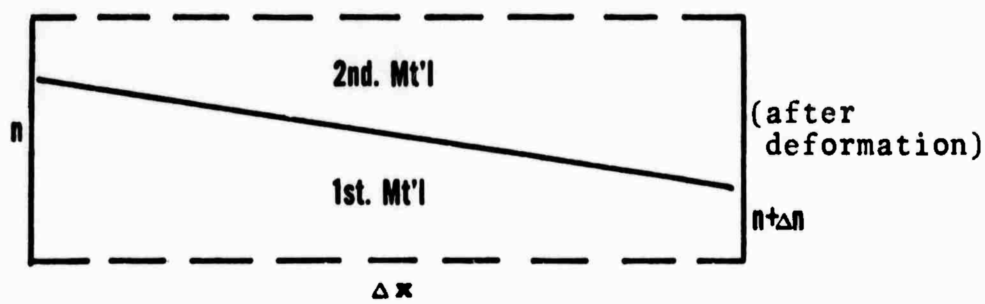

Fig. 2.1b

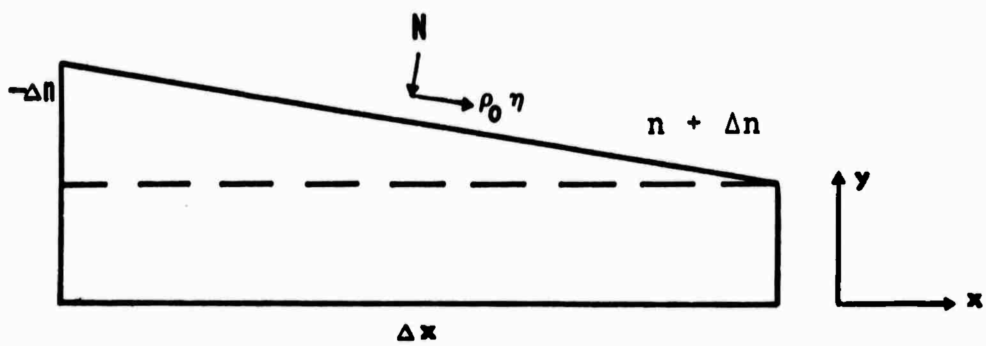

Fig. 2.1c

Fig. 2.1--Schematic of laminated structure used as conceptual model for deriving interaction terms in the TINC framework. The thickness of the first material changes from n to $n + \Delta n$ as x goes to $x + \Delta x$.

Note that for small deformations when $\partial n/\partial x$ is negligibly small, we are left with purely a shear or diffusive force, $\rho_0 \eta$.

When both the mixtures components are solids, N cannot in general be expressed in terms of normal stresses along the x, y, z directions. Our primary interest here is, however, in mixtures in which the second component is a fluid. Thus

$$\overset{(2)}{\sigma}_x = -\overset{(2)}{p} . \tag{2.17}$$

Now, if both the components are fluids, by going through an argument similar to that used in deriving Eq. (2.16), we can write

$$\rho \overset{(1)}{\beta} = \overset{(1)}{p}{}^e \frac{\partial \overset{(1)}{n}}{\partial x} + \rho_0 \overset{(1)}{\eta} \tag{2.18a}$$

$$\rho \overset{(2)}{\beta} = \overset{(2)}{p}{}^e \frac{\partial \overset{(2)}{n}}{\partial x} + \rho_0 \overset{(2)}{\eta} \tag{2.18b)*}$$

---

*It is possible to derive the same results by comparing the TINC momentum equation written in terms of effective quantities

$$\overset{(\alpha)}{n}\overset{(\alpha)}{\rho}{}^e \left(\frac{\partial \overset{(\alpha)}{v}}{\partial t} + \overset{(\alpha)}{v} \frac{\partial \overset{(\alpha)}{v}}{\partial x} \right) = \rho \overset{(\alpha)}{\beta} - \frac{\partial \overset{(\alpha)}{n}\overset{(\alpha)}{p}{}^e}{\partial x}$$

to the ordinary momentum equation for fluid flow through a variable cross-section (e.g., a nozzle):

$$\overset{(\alpha)}{n}\overset{(\alpha)}{\rho}{}^e \left(\frac{\partial \overset{(\alpha)}{v}}{\partial t} \pm \overset{(\alpha)}{v} \frac{\partial \overset{(\alpha)}{v}}{\partial x} \right) = \overset{(\alpha)}{F} + \overset{(\alpha)}{p}{}^e \frac{\partial \overset{(\alpha)}{n}}{\partial x} - \frac{\partial \overset{(\alpha)}{n}\overset{(\alpha)}{p}{}^e}{\partial x}$$

Clearly, if we write the body force $\overset{(\alpha)}{F}$ as $\rho_0 \overset{(\alpha)}{\eta}$, then

$$\rho \overset{(\alpha)}{\beta} = \rho_0 \overset{(\alpha)}{\eta} + \overset{(\alpha)}{p}{}^e \frac{\partial \overset{(\alpha)}{n}}{\partial x} .$$

Substituting from Eqs. (2.14) and (2.15) into Eqs. (2.18), we obtain

$$\frac{\partial n}{\partial x}\left(\overset{(1)}{p}{}^{e} - \overset{(2)}{p}{}^{e}\right) + \rho_0\left(\overset{(1)}{\eta} + \overset{(2)}{\eta}\right) = 0 \tag{2.19}$$

Equation (2.19) has some interesting consequences. If both the components are ideal fluids, i.e.,

$$\overset{(1)}{\eta} = \overset{(2)}{\eta} = 0 ,$$

then the effective pressures must be equal, i.e.,

$$\overset{(1)}{p}{}^{e} \equiv \overset{(2)}{p}{}^{e} = p^{e} \quad \text{(say)} \tag{2.20}$$

Alternatively, if the effective pressures are equal then it follows from Eq. (2.19) that

$$\rho_0 \overset{(1)}{\eta} = - \rho_0 \overset{(2)}{\eta} = \rho_0 \eta \quad \text{(say)} \tag{2.21}$$

To return to the case of a solid-fluid mixture, we note that

$$\rho \overset{(2)}{\beta} = - \left[\overset{(2)}{p}{}^{e} \frac{\partial n}{\partial x} + \rho_0 \eta\right] \tag{2.22a}$$

and therefore from Eq. (2.16)

$$\rho \overset{(1)}{\beta} = \left[\overset{(2)}{p}{}^{e} \frac{\partial n}{\partial x} + \rho_0 \eta\right] . \tag{2.22b}$$

In writing Eqs. (2.22), we have made no assumption concerning the equilibration of effective pressures.

We have also to prescribe the constitutive relations for $\overset{(\alpha)}{\psi}$ and $\overset{(\alpha)}{q}$. The simplest possible postulate is to

regard $\overset{(\alpha)}{\psi}$ as the interaction energy contribution due to momentum interaction body force $\rho\overset{(\alpha)}{\beta}$, i.e.,

$$\rho\overset{(\alpha)}{\psi} = -\rho\overset{(\alpha)}{\beta}\overset{(\alpha)}{v} \tag{2.23}$$

It, then, follows from Eq. (2.7) that

$$\overset{(1)}{q} = -\overset{(2)}{q} = q \quad \text{(say)} \tag{2.24}$$

Substituting for $\rho\overset{(\alpha)}{\beta}$ from Eqs. (2.22) into Eq. (2.4) and for $\overset{(\alpha)}{\psi}$ and $\overset{(\alpha)}{q}$ from Eqs. (2.23) and (2.24) into Eq. (2.5), we can write the momentum and energy conservation equations for the constituents:

$$\overset{(1)}{\rho}\left(\frac{\partial v}{\partial t} + v\,\frac{\partial v}{\partial x}\right) = \frac{\overset{(2)}{p}}{(1-n)}\,\frac{\partial n}{\partial x} + \rho_0\eta + \frac{\partial\,\overset{(1)}{\sigma}_x}{\partial x} \tag{2.25}$$

$$\overset{(2)}{\rho}\left(\frac{\partial w}{\partial t} + w\,\frac{\partial w}{\partial x}\right) = -\frac{\overset{(2)}{p}}{1-n}\,\frac{\partial n}{\partial x} - \rho_0\eta - \frac{\partial\,\overset{(2)}{p}}{\partial x} \tag{2.26}$$

and

$$\overset{(1)}{\rho}\left(\frac{\partial\,\overset{(1)}{E}}{\partial t} + v\,\frac{\partial\,\overset{(1)}{E}}{\partial x}\right) = \overset{(1)}{\sigma}_x\,\frac{\partial v}{\partial x} - \frac{\partial q}{\partial x} - v\left[\frac{\overset{(2)}{p}}{1-n}\,\frac{\partial n}{\partial x} + \rho_0\eta\right] \tag{2.27}$$

$$\overset{(2)}{\rho}\left(\frac{\partial\,\overset{(2)}{E}}{\partial t} + w\,\frac{\partial\,\overset{(2)}{E}}{\partial x}\right) = -\overset{(2)}{p}\,\frac{\partial w}{\partial x} + \frac{\partial q}{\partial x} + w\left[\frac{\overset{(2)}{p}}{1-n}\,\frac{\partial n}{\partial x} + \rho_0\eta\right], \tag{2.28}$$

where $v(w)$ denotes the particle velocity of $\overset{(1)}{s}$ $\left(\overset{(2)}{s}\right)$ constituent.

2.3 HUGONIOT RELATIONS

We shall now develop Hugoniot forms for a binary mixture based on the equations of state of the constituents. The constituents are considered to behave like compressible fluids, i.e., possessing no "strength effects". In order that a Hugoniot exist for the composite, a steady shock front must develop, implying that the shock velocity in both constituents eventually be the same. We allow interaction between the constituents through an interfacial shear force (or diffusive resistance) as well as dilatancy. The shear (diffusive) force is assumed to be important only in the vicinity of the shock front, and to vanish far away from the shock front. Since both the constituents are treated as ideal (non-viscous) fluids, one may reasonably ask how can a shear force exist at their interface. In postulating the existence of a shear force we follow the lumped parameter approach commonly employed in hydraulics. In studies of fluid flow through pipes and porous media, it is common to regard the fluid as inviscid and represent the effect of viscosity through a lumped parameter (e.g., Darcy's coefficient).

In deriving the Hugoniot relations, we shall employ the integral conservation relations (2.8) through (2.10) written in terms of the effective quantities. Equivalent Hugoniot forms for laminar composites are derived from usual continuum mechanics considerations in Appendix A. The results of this section are more general than those derived in Appendix A insofar as no restriction to the laminar composites is necessary. In fact, the results are valid whenever the area fraction equals volume fraction and are, therefore, applicable to liquid saturated porous solids and laminar composites (wave propagation in the direction of laminates).

The geometry to be considered is depicted in Fig. 2.2. The flow in both constituents is assumed to be one-dimensional on both sides of the control volume. A region of unsteady two-dimensional flow develops in the control volume immediately following the shock front, but is assumed that the flow becomes steady and one-dimensional behind the control volume. In addition, the effective pressures in the two constituents are are assumed to be equal, i.e.,

$$\overset{(1)}{p}{}^{e} = \overset{(2)}{p}{}^{e} = p^{e} \quad \text{(say)} \tag{2.29}$$

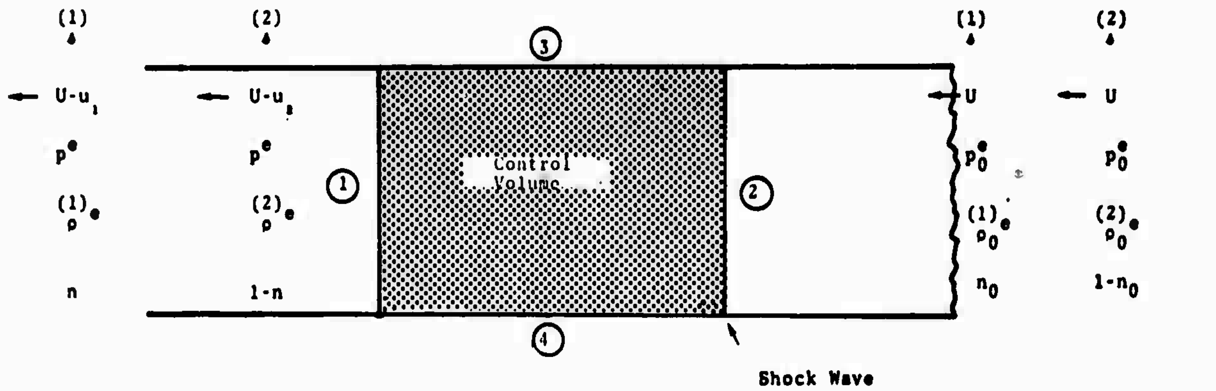

Fig. 2.2--Schematic of control volume.

The continuity equation for the $\underset{\sim}{(\alpha)}$ constituent is

$$\int_S \overset{(\alpha)}{\rho}{}^{e} \overset{(\alpha)}{n} \overset{(\alpha)}{v}_j \, n_j \, dS = 0 \tag{2.30}$$

where the surface integral is over the entire control volume. Integrating Eq. (2.30), we obtain the following mass conservation relations:

First Material

$$n \overset{(1)}{\rho}{}^{e} \left(U - u_1\right) = n_0 \overset{(1)}{\rho}{}^{e}_{0} U \tag{2.31}$$

Second Material

$$(1 - n) \overset{(2)}{\rho}{}^{e} \left(U - u_2\right) = \left(1 - n_0\right) \overset{(2)}{\rho}{}_0^{e} U \; . \qquad (2.32)$$

The momentum conservation for the $\overset{(\alpha)}{s}$ constituent yields

$$\int_S \overset{(\alpha)}{n} \overset{(\alpha)}{\rho}{}^{e} \overset{(\alpha)}{v_i} \overset{(\alpha)}{v_j} \overset{(\alpha)}{n_j} \, dS = - \int_S \overset{(\alpha)}{p}{}^{e} \overset{(\alpha)}{n} \, n_i \, dS + \int_V \rho \overset{(\alpha)}{\beta_i} \, dV \qquad (2.33)$$

where the volume integral is over the entire control volume. Recalling from Section 2.3 that

$$\rho \overset{(1)}{\beta} = - \rho \overset{(2)}{\beta} = \left[p^e \frac{\partial n}{\partial x} + \rho_0 \eta \right] , \qquad (2.34)$$

we have

$$\int_V \rho \overset{(1)}{\beta} \, dV = - \int_V \rho \overset{(2)}{\beta} \, dV = - \left[p_m \left(n - n_0 \right) + \bar{F} \right] \qquad (2.35)$$

Here p_m is some sort of average pressure acting on the material interfaces in the region where the volume fraction changes from n_0 to n.*

Integrating Eq. (2.33) and utilizing Eqs. (2.31), (2.32), and (2.35), we obtain the desired momentum conservation relations:

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*See also Appendix A. We remark here that Eqs. (2.34) and (2.35) for $\rho\beta$ are valid for wave propagation in the parallel direction only for a laminated structure. Apart from this exception, the results obtained in this chapter are independent of the direction of propagation. This question will be pursued further in Section III.

First Material

$$\overset{(1)}{n_0\,\rho_0}{}^{e}\,U\,u_1 = n\,p^e - n_0\,p_0^e - p_m\left(n - n_0\right) - \overline{F} \tag{2.36}$$

Second Material

$$\left(1 - n_0\right)\overset{(2)}{\rho_0}{}^{e}\,U\,u_2 = (1-n)p^e - \left(1 - n_0\right)p_0^e + p_m\left(n - n_0\right) + \overline{F} \tag{2.37}$$

The energy conservation relation for the $\overset{(\alpha)}{s}$ constituent is

$$\int_S \overset{(\alpha)}{n}\,\overset{(\alpha)}{\rho}{}^{e}\left[\overset{(\alpha)}{E} + \frac{1}{2}\,\overset{(\alpha)}{v^2}\right]\overset{(\alpha)}{v_i}\,n_i\,dS = -\int_S \overset{(\alpha)}{n}\,\overset{(\alpha)}{p}{}^{e}\,\overset{(\alpha)}{v_i}\,\overset{(\alpha)}{n_i}\,dS - \int_S \overset{(\alpha)}{\hat{q}_j}\,n_j\,dS \tag{2.38}$$

Recalling from Section 2.2 that

$$\overset{(1)}{\hat{q}} = -\overset{(2)}{\hat{q}} = q\ ,$$

we have

$$-\int_S \overset{(1)}{\hat{q}_j}\,n_j\,dS = \int_S \overset{(2)}{\hat{q}_j}\,n_j\,dS = \overline{Q} \tag{2.39}$$

Integrating Eq. (2.38) and utilizing Eqs. (2.31), (2.32), and (2.39), we obtain the following energy conservation relations:

First Material

$$n_0 \overset{(1)}{\rho}{}^e_0 \, U\left[\overset{(1)}{E} - \overset{(1)}{E}_0 + \frac{1}{2} u_1^2 - u_1 U\right] = -\left[np^e\left(U-u_1\right) - n_0 p_0^e U\right] + \bar{Q} \qquad (2.40)$$

Second Material

$$\left(1-n_0\right) \overset{(2)}{\rho}{}^e_0 \, U\left[\overset{(2)}{E} - \overset{(2)}{E}_0 + \frac{1}{2} u_2^2 - u_2 U\right] = -\left[(1-n)p^e\left(U-u_2\right) - \left(1-n_0\right) p_0^e U\right] - \bar{Q} \qquad (2.41)$$

Equations (2.31), (2.32), (2.36), (2.37), (2.40), and (2.41) constitute the Hugoniot relations for a fully saturated porous solid $\left(\overset{(1)}{n} \neq 0,\ \overset{(2)}{n} = 1 - \overset{(1)}{n},\ \overset{(3)}{n} = 0\right)$.* In addition to these, we have two equations of state, i.e.,

$$p^e = P_1\left(\overset{(1)}{E}, \overset{(1)}{\rho}{}^e\right) \qquad \text{(First Material)} \qquad (2.42)$$

$$p^e = P_2\left(\overset{(2)}{E}, \overset{(2)}{\rho}{}^e\right) \qquad \text{(Second Material)} \qquad (2.43)$$

Thus if the initial state of the composite is known, we have a system of twelve unknowns $\left(\overset{(1)}{\rho}{}^e, \overset{(2)}{\rho}{}^e, p^e, \overset{(1)}{E}, \overset{(2)}{E}, n, p_m, u_1, u_2, \bar{Q}, \bar{F}, U\right)$ with eight equations [(2.31), (2.32), (2.36),

---

*Hugoniot relations for a dry porous solid may be obtained in a straightforward manner by integrating Eqs. (2.30), (2.33), and (2.38) and noting that

$$\overset{(2)}{\rho}{}^e = \overset{(2)}{p}{}^e = \rho\beta = q = 0$$

$$\overset{(1)}{p}{}^e = p^e \neq 0 \ .$$

We shall not, however, pursue this question any further here.

(2.37), (2.40), (2.41)]. To make the system determinate, we need to prescribe four additional relations. Assuming that we prescribe a shock variable, this still leaves us with three more unknowns than the number of equations.

Broadly speaking, the various constitutive assumptions may be divided into two categories, i.e., those pertaining to (i) momentum partitioning and (ii) energy partitioning. One needs to introduce two constitutive assumptions for momentum partitioning and one for energy partitioning.

Torvik[3] neglects the interfacial shear force, $\bar{F}$, and introduces a constitutive assumption for p_m:

$$p_m = \left(p^e + p_0^e \right)/2 \tag{2.44}$$

The latter assumption is tantamount to assuming that the pressure varies linearly in the region where volume fraction changes from n_0 to n. Note that in Torvik's model, the two constituents are allowed to have different particle velocities. Tsou and Chou,[2] on the other hand, neglect p_m and require the two constituents to move together, i.e.,

$$u_1 = u_2 = u_0 \ . \tag{2.45}$$

The specification of these two conditions determines $\bar{F}$ uniquely and one may not introduce a separate constitutive assumption for $\bar{F}$ in this case. In the general case, $\bar{F}$ and p_m may depend on all the kinematic and thermodynamic variables. We examine the question of a constitutive assumption for p_m further within the context of a mechanical model in Section 2.4.

The constitutive assumption for energy partitioning is introduced through the heat flow term, $\bar{Q}$. Both Torvik and Tsou and Chou make use of the adiabatic assumption, i.e., $\bar{Q} = 0$. Note that in this case energies $\overset{(1)}{E}$ and $\overset{(2)}{E}$ may be eliminated from the constitutive relations (2.42) and (2.43) through use of Eqs. (2.40) and (2.41). This leaves one with a purely mechanical system. Tsou and Chou also discuss the consequences of taking the temperatures in both constituents to be the same, i.e., $T_1 = T_2 = T$. In this case, $\overset{(1)}{E}$ and $\overset{(2)}{E}$ may be eliminated from the constitutive relations (2.42) and (2.43) in favor of temperature T. The energy balances (2.40) and (2.41) then merely serve to determine $\overset{(1)}{E}$ and $\overset{(2)}{E}$ in terms of kinematic variables and a fixed temperature parameter. This is therefore a mechanical theory with reference to temperature only as a parameter which defines a family of mechanical constitutive laws. Furthermore, this case is equivalent to the PTEQ case considered in 3SR-267. In general, $\bar{Q}$ may depend upon all thermodynamic and kinematic variables, i.e.,

$$\bar{Q} = \bar{Q}\left(p^e, \overset{(1)}{\rho}{}^e, \overset{(2)}{\rho}{}^e, T_1, T_2, u_1, u_2\right) . \tag{2.46}$$

The question of when a particular assumption regarding $\bar{Q}$ is appropriate leads us directly to a consideration of the time of interest $\left(t_i\right)$ and the thermal relaxation time $\left(t_r\right)$. We will return to this question in Section 2.5.

2.4 MECHANICAL MODEL AND NUMERICAL RESULTS

In this section, we shall examine the mechanical model and give some numerical results. From Section 2.3, we have the following mass and momentum conservation equations for the mechanical model:

$$n \overset{(1)}{\rho}{}^{e}\left(U - u_1\right) = n_0 \overset{(1)}{\rho}{}_0^{e} U \tag{2.31}$$

$$(1 - n) \overset{(2)}{\rho}{}^{e}\left(U - u_2\right) = \left(1 - n_0\right) \overset{(2)}{\rho}{}_0^{e} U \tag{2.32}$$

$$n_0 \overset{(1)}{\rho}{}_0^{e} U u_1 = n p^e - n_0 p_0^e - p_m \left(n - n_0\right) - \bar{F} \tag{2.36}$$

$$\left(1 - n_0\right) \overset{(2)}{\rho}{}_0^{e} U u_2 = (1-n)p^e - \left(1 - n_0\right)p_0^e + p_m\left(n - n_0\right) + \bar{F} \tag{2.37}$$

In addition to these, we have two mechanical equations of state which we take as polynomial functions of the compression:

$$p^e = P_1\left(\mu_1\right) = A_1 \mu_1 + B_1 \mu_1^2 + F_1 \mu_1^3 \tag{2.47}$$

$$p^e = P_2\left(\mu_2\right) = A_2 \mu_2 + B_2 \mu_2^2 + F_2 \mu_2^3 ,$$

where

$$\mu_1 = \overset{(1)}{\rho}{}^{e} / \overset{(1)}{\rho}{}_0^{e} - 1 , \quad \mu_2 = \overset{(2)}{\rho}{}^{e} / \overset{(2)}{\rho}{}_0^{e} - 1 \tag{2.48}$$

Given the initial state of the composite we have nine unknowns $\left(n, \overset{(1)}{\rho}{}^{e}, \overset{(2)}{\rho}{}^{e}, U, u_1, u_2, p^e, p_m, \bar{F}\right)$ with six equations to determine them. To make the system determinate, we need to prescribe one shock variable and make two constitutive assumptions.

Tsou and Chou[2] make the system determinate by assuming that both the constituents move together $\left(u_1 = u_2 = u_0\right)$ and neglecting p_m. We will relax their second assumption and investigate its effect upon $\bar{F}$. Both p_m and $\bar{F}$ may be eliminated by adding (2.36) and (2.37) to yield the overall momentum conservation relation:

$$u_0 \, U \left\{ n_0 \, \overset{(1)}{\rho}{}_0^e + \left(1 - n_0\right) \overset{(2)}{\rho}{}_0^e \right\} = p^e - p_0^e \tag{2.49}$$

Thus when we prescribe a shock variable (say U), the system of Eqs. (2.31), (2.32), (2.47), (2.48) and (2.49) forms a determinate system for the unknowns u, $\overset{(1)}{\rho}{}^e$, $\overset{(2)}{\rho}$, p^e, and n. It is readily seen that this model is equivalent to the mechanical PEQ model used in 3SR-267. In Table 2.1 we give the parameters for the polynomial functions, Eqs. (2.47) and (2.48), when fitted to p-V data (see 3SR-267 for details) for poreless $\overline{\text{NTS}}$* tuff, $\overset{(1)}{s}$, and water, $\overset{(2)}{s}$. For future convenience, we also give in Table 2.1, equation of state parameters for saturated wet tuff (water mass fraction $M_W = 15\%$) obtained from the water and poreless $\overline{\text{NTS}}$ tuff fits upon imposing the mechanical PEQ model.

To investigate the effect of a constitutive assumption for p_m on $\bar{F}$, we ran calculations for a mixture of water and tuff for the following initial state:

$$\begin{aligned} p_0^e &= 0 \\ n_0 &= 0.703 \\ \overset{(1)}{\rho}{}_0^e &= 2.4 \text{ g/cc} \\ \overset{(2)}{\rho}{}_0^e &= 1.0 \text{ g/cc} \end{aligned} \tag{2.50}$$

*The $\overline{\text{NTS}}$ prefix merely indicates that the representative poreless tuff material parameters were deduced from data for a variety of NTS tuffs. In 3SR-267 this hypothetical material was called S^3 compacted dry tuff.

TABLE 2.1

Parameters in the Fits of p-V Data for Poreless $\overline{\text{NTS}}$ Tuff, Water and the Mechanical PEQ Model for Wet Tuff

M_w = 15% or n_e = 0.703

Material	A(ergs/cc)	B(ergs/cc)	F(ergs/cc)	ρ_e (g/cc)
Water (< 250 kbar)	2.19534×10^{10}	5.2138×10^{10}	2.3181×10^{11}	1.0
Poreless $\overline{\text{NTS}}$ Tuff (< 200 kbar)	2.4576×10^{11}	2.98697×10^{11}	6.14886×10^{10}	2.4
Saturated Wet Tuff (< 200 kbar) (M_w = .15)	5.96758×10^{10}	6.31245×10^{11}	-2.60228×10^{11}	1.9835

The shock variable prescribed was $u_0 = u_1 = u_2 = 7.786 \times 10^4$ cm/sec. In Table 2.2 we give the results for various constitutive assumptions for p_m.

It is evident from Table 2.2 that the constitutive assumption regarding p_m has a great influence on the magnitude of the mean interaction diffusion force $\overline{F}$.

In contrast to the work of Tsou and Chou, Torvik[3] allows the two constituents to have different velocities, $u_1 \neq u_2$. He neglects $\overline{F}$ and introduces a constitutive assumption for p_m, Eq. (2.44). To evaluate the effect of Torvik's constitutive assumption for p_m, calculations were run for a mixture of water and tuff with the initial conditions, Eq. (2.50), identical to the ones for the calculation of Table 2.2. The shock variable prescribed was p^e. In Table 2.3, we give the results for two values of p^e (50.9 and 100 kbar) and various constitutive assumptions for p_m.

The 50.9 kbar case is identical to the one discussed in 3SR-267 in connection with the detailed CRAM code calculation for a step pulse propagating parallel to the layers of a water/tuff laminated composite. Note that in this case the constitutive assumption for p_m does not produce a significant effect and indeed Torvik's analysis did give good agreement with the CRAM calculation for this case. This may be explained by the fact that $\left(n - n_0\right)/n_0$ is less than one percent in this case. The situation is, however, different for the 100-kbar case where $\left(n - n_0\right)/n_0$ is of the order of 6 percent. This shows up as a 4-percent change in shock velocity when p_m is taken to be $p^e/4$ instead of p^e. The case where $p_m = p^e/2$ lies in between these two. We can conclude that whenever $\left(n - n_0\right)/n_0$ is large, the constitutive assumption for p_m may affect the solution in a significant way.

TABLE 2.2

Effect of Assumed Value of Mean Pressure p_m on the Hugoniot Predictions for the Composite when using Mechanical Models of the Water and Tuff Constituents

The Tsou and Chou Assumption corresponds to $p_m = 0$ (Here $M_w = 15\%$ or $n_0 = 0.703$ and the particle velocity is $u_0 = u_1 = u_2 = 7.786 \times 10^4$ cm/sec)

p_m	$\overline{F}$ (kbar)	p^e(kbar)	U (cm/μsec)	${}^{(1)}\rho^e$ (g/cc)	${}^{(2)}\rho^e$ (g/cc)	n
p^e	-8.37	56.81	0.368	2.849	1.515	0.751
$p^e/4$	-6.31					
$p^e/64$	-5.67					
0	-5.62					

TABLE 2.3

Effect of Assumed Value for the Mean Pressure p_m on the Hugoniot Predictions for the Composite when using Mechanical Models of the Water and Tuff Constituents

Torvik's Assumption corresponds to $p_m = p^e/2$.
(Here M_w = 15% or $n_0 = 0.703$.)

		$p_m = p^e$	$p_m = p^e/2$	$p_m = p^e/4$	
p^e = 50.9 kbar	U	0.3879	0.3885	0.3889	cm/μsec
	u_1	0.0547	0.0544	0.054	cm/μsec
	u_2	0.1312	0.1320	0.1326	cm/μsec
	n	0.6991	0.6984	0.6979	
	$\rho^{(1)}{}_e$	2.8093	2.8093	2.8093	g/cc
	$\rho^{(2)}{}_e$	1.4915	1.4915	1.4915	g/cc
p^e = 100 kbar	U	0.4689	0.4773	0.4837	cm/μsec
	u_1	0.0889	0.0846	0.0815	cm/μsec
	u_2	0.2133	0.2247	0.2328	cm/μsec
	n	0.6699	0.6599	0.6530	
	$\rho^{(1)}{}_e$	3.1076	3.1076	3.1076	g/cc
	$\rho^{(2)}{}_e$	1.6501	1.6501	1.6501	g/cc

2.5 ENERGY PARTITIONING

Towards the end of Section 2.3, we briefly referred to the various possible constitutive assumptions regarding the heat flow term, $\overline{Q}$, and the question of energy partitioning. The adiabatic assumption ($\overline{Q} = 0$) may be employed when the thermal relaxation time (t_r, see below) is much larger than the time of interest (t_i). Similarly, the isothermal assumption ($T_1 = T_2$) is appropriate in the reverse case, i.e., when the time of interest is much larger than the thermal relaxation time. In the intermediate range $\left(t_r \sim 0(t_i)\right)$, $\overline{Q}$ can depend on T_1, T_2 and all the kinematic variables. Thus, in any choice of a constitutive assumption for $\overline{Q}$, thermal relaxation time, t_r, plays a central role.

It was pointed out in 3SR-267 that a crude estimate of the thermal relaxation time behind the leading shock wave can be obtained by setting the Fourier modulus for a spherical water pore equal to order one, i.e.,

$$F_0 = \frac{\alpha t_r}{a^2} = o(1) \qquad (2.51)$$

where

α = thermal diffusivity, cm^2/sec

t_r = relaxation time, sec

a = pore radius, cm

Specifically, the t_r from this relationship is that required for a sphere to equilibrate with an environment of infinite extent and conductivity (see Charts 2, 4, 8, Schneider[3]).

A complimentary analysis has been conducted to ascertain the thermal equilibration criteria in the slab geometries depicted in Fig. 2.3. The initial temperature profile is

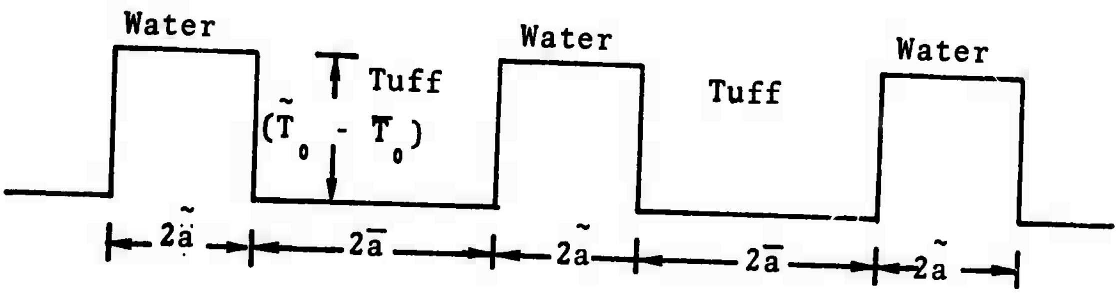

Fig. 2.3--Initial Temperature Profile in Slab Geometry

assumed constant in each layer of the "mixture". Moreover, the water layer temperatures are initially at one given temperature and the tuff laminates at another. Thus, the problem has a symmetry which makes it amenable to solution by Laplace transform techniques. The results are summarized by an expression for the extent to which temperature equilibration is achieved in the water by time, t,

$$\eta_{TEQ} \equiv \frac{\tilde{T} - \tilde{T}_0}{\left(\tilde{T} - \tilde{T}_0\right)_{t=\infty}} = 1 - \frac{\tilde{\tau} e^{-t/\tilde{\tau}} - \tau_1 e^{-t/\tau_1}}{\tilde{\tau} - \tau_1} \qquad (2.52)$$

where

$$\tilde{\tau} = \tilde{a}^2/2\tilde{D} \qquad \bar{\tau} = \bar{a}^2/2\bar{D}$$

$$\tau_1 = \frac{2}{3}\,\frac{\bar{\tau} - \tilde{\tau}}{\Theta + 1} \qquad \Theta = \frac{\tilde{\rho}\,\tilde{C}_V\,\tilde{a}}{\bar{\rho}\,\bar{C}_V\,\bar{a}}$$

and the superscripts tilda and bar refer to water and tuff, respectively. The specific heats and thermal diffusivities are denoted by C_V and D respectively. At infinite time, η_{TEQ} has a limit of unity, indicating that the change in temperature of the water is equal to that required for thermal equilibrium.

Utilization of either of these equilibration relations, Eqs. (2.51) or Eq. (2.52), leads to similar conclusions. A thermal equilibrium (TEQ) matrix is presented below wherein the extent of thermal equilibration is indicated for nine combinations of slab size and pulse duration for a mixture with water mass fraction of M_w = 15%. These results are based on Eq. (2.52) but utilization of Eq. (2.51) provides almost identical matrices.

		PULSE DURATION		
SLAB	THICKNESS	10^{-6} sec	10^{-3} sec	10^{-2} sec
Medium	2 mm	NOTEQ	NOTEQ	NOTEQ
Medium Fine	.2 mm	NOTEQ	PARTEQ	TEQ
Fine	20 μ	PARTEQ	TEQ	TEQ

where: (1) when $\eta_{TEQ} < .1$, thermal equilibrium is not achieved (NOTEQ)

(2) when $.1 < \eta_{TEQ} < .9$, partial thermal equilibrium is achieved (PARTEQ)

(3) when $\eta_{TEQ} > .9$, the thermal equilibrium is achieved (TEQ)

In these calculations, values of thermal diffusivity were taken from Ref. 5.

$$\text{(Water)}\quad \tilde{D} = 1.5 \times 10^{-3}\ \text{cm}^2/\text{sec}$$

$$\text{(Tuff)}\quad \overline{D} = 10.4 \times 10^{-3}\ \text{cm}^2/\text{sec}$$

It is readily apparent that thermal equilibrium is never attained under laboratory conditions (pulse durations of 10^{-6} sec) even for grain sizes down to twenty microns.

Scaling the Rainier nuclear test results presented by Nuckolls,[6] by the yield to the 1/3 power, indicates that a 50-kbar pulse with a duration of 20 milliseconds is encountered at a radius of 172 meters for an underground explosion of 10 MT. This corresponds to about 10 milliseconds for a megaton and a millisecond at the one-kiloton level. Thus, the lower right-hand corner of the TEQ matrix represents physically realistic test conditions wherein TEQ is possible.

Although the exact value for tuff thermal diffusivity would vary from sample to sample, its order of magnitude is conservatively given by the value used in these calculations. Because the water's thermal diffusivity is low compared to the tuff, it acts as the major inhibitor to complete thermalization of the mixture. It is relevant, therefore, to consider if a dramatic increase in water's effective diffusivity would drastically alter the TEQ matrix for a mixture with $M_w = 15\%$. This increase would come about due to turbulence in the water pores, convective effects, reverberations, or molecular changes in the water under high compression. Thus, for an order of magnitude increase in water's thermal diffusivity, the TEQ matrice is changed to:

		PULSE DURATION		
SLAB	THICKNESS	10^{-6} sec	10^{-3} sec	10^{-2} sec
Medium	2 mm	NOTEQ	NOTEQ	PARTEQ
Medium Fine	.2 mm	NOTEQ	TEQ	TEQ
Fine	.02 mm	PARTEQ	TEQ	TEQ

$$\text{(Water) } \tilde{D} = 15.0 \times 10^{-3} \text{ cm}^2/\text{sec}$$

$$\text{(Tuff) } \bar{D} = 10.5 \times 10^{-3} \text{ cm}^2/\text{sec}$$

The second TEQ matrix doesn't alter the general conclusions concerning the existence of TEQ states in laboratory or field test conditions. It does further emphasize that particle/pore sizes for tuff/water mixtures in underground test sites should be determined.

III. ENERGY PARTITION IN WET TUFF

3.1 INTRODUCTION

Water-saturated rocks are commonly encountered in many field locations. Concentrations are often as high as 25 percent water (by mass) for some porous tuffs. To characterize shock-wave propagation in such materials, it is of interest to clarify the principal effects of water saturation.

For strengthless materials (fluids), these effects may be considered in two categories, mechanical and thermal. In those instances wherein not enough time is available for significant thermal energy exchange between the constituents, but pressure equilibration is achieved behind the shock front, additional constitutive relations are required to fully specify the Hugoniot of any composite material (as discussed in Chapter II). However, if the additional constraint of thermal equilibrium is imposed, a definite Hugoniot for the composite can be calculated without resort to additional mechanical relations.

In the following study, a comparison is made between two mechanical equilibrium models and the PTEQ equation of state for various (strengthless) mixtures of poreless $\overline{\text{NTS}}$ tuff and water up to pressures of 200 kbar. Calculations of shock and release states are presented. The enhanced shock heating effects in materials initially containing unfilled pores that are completely crushed by a shock-wave are also considered.

The PTEQ theory, first presented in 3SR-267, differs from the thermal equilibrium formulations in the earlier studies by Butkovich,[7] and Wagner and Louie,[8] which presume the rock and water to be vaporized by shock waves in the megabar range. In these studies the gases mix perfectly and the hydrodynamic pressure is given by the sum of the partial pressures. In the present study, the thermodynamic regime of interest precludes shock vaporization, and does

not include shock-induced phase transitions of the tuff or water. The possibility of water vaporization at low pressures upon release from higher pressure shock states, however, is treated. (In fact, this phenomena has been observed in saturated alluvium by Anderson, et al.[9]).

The first of the mechanical formulations, referred to as the PEQ model in 3SR-267, is based on the implicit assumption that the mechanical interactions occurring in the shock front result in Hugoniot states consisting of a pressure equilibrium mixture of the pure components at their independent shock states. A number of investigators (Butkovich,[10] Lysne,[11] Rosenberg, et al.[5]) have also utilized such a mixture hypothesis in their studies of shock response in wet rocks.

The second mechanical equilibrium mode, P*EQ, is the result of a study conducted during the past year and is documented for the first time in this report. It is based on the assumption that the entropy of the water component is determined by a double-shock process and remains at that level behind the leading portion of the wave front. This hypothesis can be justified if the water is not finely interspersed, so that the shock impedance mismatch between tuff and water results in a two-stage shocking of the water.

The comparative nature of this investigation requires that the equations of state of the constituents of the mixture be thermodynamically consistent. A critical examination of the water and poreless $\overline{\text{NTS}}$ tuff equations of state presented in 3SR-267 revealed that some minor modifications to both formulations were required. These corrections are fully detailed in Appendix B, which also contains a tabulation of the equations of state employed in this report. In the interest of completeness, the shock Hugoniots for water, $\overline{\text{NTS}}$ tuff, and PTEQ mixtures are also given. These values supercede those reported in 3SR-267.

3.2 PTEQ AND PEQ MIXTURE MODELS

The form of the equations of state often utilized in ground motion computer codes, is given by

$$p = P(V, E) \tag{3.1}$$

where p refers to the hydrodynamic pressure, V to specific volume, and E to the specific internal energy. If each constituent of the mixture under consideration is described by a state equation of the form (3.1), pressure equilibrium between the constituents requires that,

$$P_i(V_i, E_i) = P_j(V_j, E_j) = \ldots \tag{3.2}$$

where the subscripts i and j refer to the ith and jth component. Overall characterization of the mixture is obtained by taking

$$P(V, E) = P_i(V_i, E_i) = \ldots \tag{3.3}$$

where

$$V = \sum M_i V_i \ , \qquad E = \sum M_i E_i \tag{3.4}$$

and M_i is the mass fraction of the ith constituent.

3.2.1 PTEQ

The pressure equilibrium constraint, without additional conditions, does not provide a unique definition of the mixture state. For a mixture of materials, it provides only $k + 2$ equations for $2k + 2$ unknowns. Let us introduce thermal equations of state for the constituents,

$$E_i = E_i(V_i, T_i) \tag{3.5}$$

where T is the absolute temperature. If we impose the

additional constraint of thermal equilibrium, i.e.,

$$T = T_i = T_j = \dots \quad , \tag{3.6}$$

the algebraic loop is closed. One may therefore obtain a definite mixture state by simultaneously solving Eqs. (3.3) through (3.6) for given values of E and V. These are the PTEQ mixture states. It is a straightforward procedure to calculate these states with an iterative computer program (see 3SR-267 for details).

PTEQ mixtures may then be considered as a homogeneous material for which the equation of state is known. Thus, the Hugoniot shock state can be computed by solving the energy conservation equation,

$$E_H - E_0 = \frac{p_H + p_0}{2}\left(V_0 - V_H\right) , \tag{3.7}$$

and the PTEQ equation of state for arbitrary values of E_H, p_0, V_0, E_0. (The subscripts 0 and H refer to conditions before and behind the disturbance.)

3.2.2 PEQ

In the PEQ mixture model, the individual constituents are assumed to (shock) compress to states on the Hugoniot of the pure material. Similarly, upon release from a shock state, each mixture component releases along the isentropic path of the pure material. This mixture model is most conveniently represented by introducing the specific entropy, S, given by

$$TdS = dE - pdV$$

$$S - S_0 = -\int_{V_0}^{V} \frac{pdV}{T} + \int_{E_0}^{E} \frac{dE}{T} \tag{3.8}$$

The equations of state of the components may be written

$$p_i = P_i(V_i, S_i) \ . \tag{3.9}$$

The shock state is defined by $S_H(V)$, and the pressure equilibrium condition (3.2) is written

$$P_H\big(V, S_H(V)\big) = P_{H_i}\big(V_i, S_{H_i}(V_i)\big) = P_{H_j}\big(V_j, S_H(V_j)\big) = \ldots \tag{3.10}$$

where

$$S_H = \sum M_i \quad S_{H_i} \tag{3.11}$$

H = subscript referring to the Hugoniot of the material.

It can be shown that this formulation provides shock states that are in full agreement with the overall jump conditions. From Eqs.(2.35) and (2.36), the momentum equations of the constituents are given by

$$\overset{(i)}{n}_0 \ \rho_{0i} \ Uu_i = \overset{(i)}{n} p - \overset{(i)}{n}_0 \ p_0 + \int_V \rho_i \overset{(i)}{\beta} dV \tag{3.12}$$

If we sum these equations, the total contribution of the interaction forces must vanish and the overall momentum equation is given by

$$\overset{(1)}{n}_0 \ \rho_{01} \ Uu_1 + \overset{(2)}{n}_0 \ \rho_{02} Uu_2 + \ldots = \sum_i \overset{(i)}{n} p - \sum \overset{(i)}{n}_0 p_0$$
$$= p - p_0 \tag{3.13}$$

In the PEQ model, the Hugoniot states of the ith constituent are assumed to be,

$$\rho_{0i} \ Uu_i = p_H\Big\{V_i, S_H(V_i)\Big\} - p_0$$

Multiplying both sides of this equation with $n_0^{(i)}$ and summing over i gives the same result as Eq. (3.13). Thus, by explicitly avoiding the interaction term, $\int \rho\beta\, dV$, a consistent Hugoniot solution can be obtained.*

Presuming that a complete equation of state of each constituent is known, the PEQ release states can be computed in a manner analagous to that of the shock Hugoniot, Eqs. (3.10), (3.11). Each shock pressure implies a unique entropy value, $S(p_H)$. The adiabatic release path of the constituent is given by

$$p_{adiabat} = P\big(V,\ S(p_H)\big) \quad . \tag{3.15}$$

Hence, the adiabat of the mixture is obtained by solving the pressure equilibrium equations under the constraint that the entropy of each constituent is constant,

$$P\big(V,\ S(p_H)\big) = P_i\big(V_i,\ S_i(p_H)\big) = P_j\big(V_j,\ S_j(p_H)\big) = \ldots \tag{3.16}$$

where

$$S(p_H) = \sum M_i\ S_i(p_H)$$
$$V = \sum M_i\ V_i$$

The condition that the constituent entropy at a given pressure is just that of the pure material at that same shock pressure, replaces the thermal equilibrium condition utilized in the PTEQ model. Mechanically speaking, it is also necessary to presume that dynamic equilibrium (i.e., $u_i = u_j = \ldots = u$) is achieved behind the shock wave before the interaction term in Eq. (3.12) can be calculated.

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*It should be remarked that when one assumes dynamic equilibrium in the PEQ mixture model, i.e., $u_1 = u_2 = \ldots = u_i$, the Q term in the energy equation is not zero (see Garg and Kirsch, "Hugoniot Analysis of Composite Materials", Jour. Composite Materials, October 1971).

3.3 P*EQ MODEL

It is apparent from the discussions in Chapter II (and the preceding section) that the PEQ model is one of many possible pressure equilibrium formulations that can satisfy the (overall) jump conditions across a steadily propagating disturbance. An alternative to this hypothesis, based on a specific type of mechanical interaction, is the P*EQ model for saturated geologic materials.

The interaction under consideration is an effect of inhomogeneities in wet geologic composites. Internal stress reverberations can be induced in pores and grains due to shock wave reflections at the interfaces. If a water-saturated composite is thought of as a sequence of bilaminates, first rock, then water, etc., the shock wave propagating through the material will be affected by shock reflections at the interfaces.

Shock pressure versus particle velocity curves for water and tuff may be employed to demonstrate the basic shock wave interaction at the tuff-water interface (see Fig. 3.1). For a given particle velocity, u_L, two characteristic cases may be considered. First, the tuff (T) is shocked to the pressure, p_{T_1}. Upon impact with the tuff/water interface, this shock wave is transmitted into the water (W) at a reduced pressure, p_{W_2}, because of the impedance mismatch between the two materials. A release wave propagates back into the tuff to maintain the increased velocity of the interface. The water is then double-shocked to p_{W_3} when the first shock is reflected off the succeeding water/tuff interface.

The water may also be considered to have been shocked to particle velocity, u_L, and pressure, p_{W_4}. At the water/tuff interface, this shock is transmitted into the tuff at the

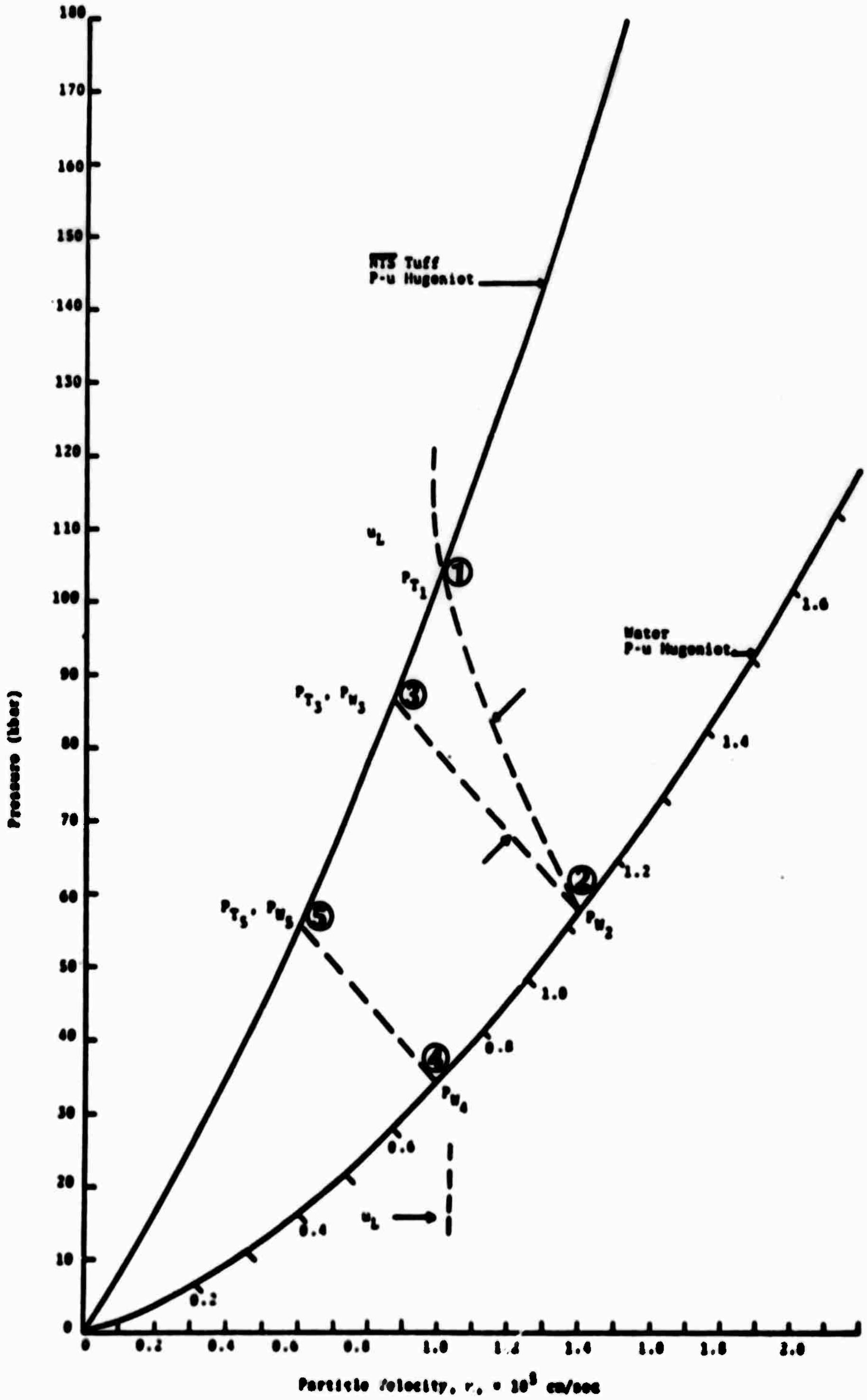

Fig. 3.1--Graphical illustration of the characteristic wave interactions at $\overline{\text{NTS}}$ tuff/water interfaces. (Tic marks on water Hugoniot are intersections with $\overline{\text{NTS}}$ release adiabats for various values of u_L.)

higher pressure, p_{T_5}, and a second shock is reflected back into the water to match the higher pressure level at the interface (and lower particle velocity).

These initial interactions are the limiting cases of those which can occur at a given interface for a particle velocity, u_L. They are the first of a series of reverberations which result from interactions of the secondary waves at neighboring interfaces.

The shock "front" resulting from such a process may have a much larger thickness than an ordinary shock wave in a homogeneous material. The leading shock may be thin, but the ensuing interaction regime could be of relatively large extent. Equilibrium values for such a disturbance have physical meaning only when they are averaged over lengths comparable to/or larger than the thickness of the overall shock front.

The P*EQ theory assumes that an (average) equilibrium state exists. It is calculable from the Hugoniot jump conditions once the equilibrium value of the water entropy is known at a given particle velocity. This is stated algebraically, as follows:

$$P(V,S) = P_W(V_W, S_W) = P_T(V_T, S_T) \qquad (3.17)$$

$$S_W = S_W(u, \overset{(2)}{n_0}) \qquad (3.18)$$

$$\frac{u^2}{2} = \frac{P + P_0}{2} (V_0 - V) \qquad (3.19)$$

where the W and T subscripts refer to water and tuff, respectively. The specific volume of one mix is given by Eq. (3.4).

This system of four equations in five unknowns yields the Hugoniot states for arbitrary values of u (the average particle velocity behind the wave front). Since a

different constraint on the energy partition has been imposed in the P*EQ mode (e.g., the still unspecified $S_W(u, \overset{(2)}{n_0})$), different thermal states could be anticipated to result in a P*EQ formulation.

Release from a P*EQ shock state is calculated in the same manner as outlined for the PEQ model. The entropy levels are held constant at those values which result from the irreversible processes in the wave front. An arbitrary release path for a mixture is calculated as in Eq. (3.16). Of course, the values of S_1 and S_2 differ from those utilized in the PEQ formulation.

3.3.1 The Double-Shock Entropy Function, $S_W(u, \overset{(2)}{n_0})$ - SKIPPER Code Calculations

The essence of the P*EQ formulation is the hypothesis that the entropy level achieved in the water is determined by the initial shock interaction between the water (in a pore) and its tuff surroundings. A numerical test of this hypothesis has been accomplished in a series of numerical step-pulse experiments with bilaminates of water and tuff representing the saturated composite (see Fig. 3.2). The SKIPPER wave propagation code was utilized with full thermodynamic equations of state for poreless NTS tuff and water (see Appendix B). The rationale behind utilizing a 1-D code, such as SKIPPER, is based on the 2-D CRAM code calculations of shock wave propagation into an array of water inclusions placed in a tuff matrix (previously reported in 3SR-267). A reverberation process consisting of localized wave interactions at the inclusion interfaces appeared to be the mechanism by which the two constituents asymptotically approached an equilibrium condition. This was observed to be markedly similar to bilaminate calculations.

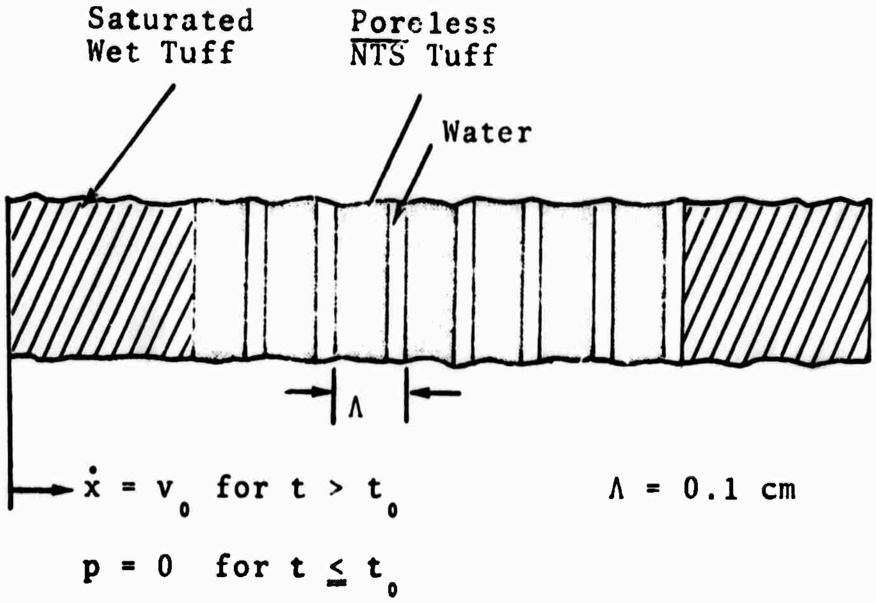

Fig. 3.2--Schematic of the bilaminate configurations utilized in the present series of SKIPPER code calculations. As many as 25 bilaminates can be placed between the two end blocks.

The present series of SKIPPER runs provided valuable insight into the effects of the wave interactions on the overall energy partitioning between the constituents. These results have been incorporated into an expression for $S_W(u, n_0^{(2)})$. In the following section, all of the SKIPPER results are not presented. Only those aspects of the calculations most pertinent to the prediction of mechanical equilibrium states are given in this section. A summary of the SKIPPER runs is given in Table 3.1. More detailed information on the oscillatory response of the bilaminate structure is contained in the SKIPPER series summary provided in Appendix C.

3.3.2 Numerical Experiments - Periodicity Effects

The orderly sequences of recurring bilaminates, utilized in all but one of the SKIPPER runs, have proven to be particularly useful because the interactions take on an orderly pattern related to the periodic structure of the binary composite. Equilibrium is approached in a regular, oscillatory manner, whereby mechanical energy is transferred from one component to the other in succeedingly smaller and smaller amounts. Although the orderly sequence of bilaminates does provide a "patterned" response to a disturbance, it may be postulated that the characteristic interactions are the same as in a completely random geometry. Therefore, the thermodynamic states achieved for both geometries, averaged over a sufficient distance behind the shock front, should be nearly identical. This, in fact, is the tacit assumption behind treating composite materials as homogeneous mixtures. The first two runs in this series, 770 and 775, were conducted to (numerically) verify this postulate as well as gain insight into the mechanical energy exchange between the tuff and water laminates.

TABLE 3.1

SKIPPER Series — $\overline{\text{NTS}}$ Poreless Tuff/Water Bilaminates

Run No.	(1) n_o	(2) n_o	M_W	$u \times 10^5$, cm/sec	Comments
770	.703	.297	.15	.7786	Orderly Sequence
775	.703	.297	.15	.7786	Random Sequence
780	.703	.297	.15	.7786	(Double Zoning, 10 Zones/Water Laminate)
785	.703	.297	.15	1.25	Orderly Sequence
800	.557	.443	.25	1.25	Orderly Sequence
805	.557	.443	.25	2.2	Orderly Sequence

A 15 percent mass fraction of water in bilaminates (corresponding to $n_0^{(1)} = .703$, $n_0^{(2)} = .297$) was utilized in these runs with a step-pulse velocity of 7.786×10^4 cm/sec, applied to the left boundary of the wet tuff end block. Run 770 was conducted with an orderly sequence of 0.1 cm thick bilaminates (identical to that utilized in earlier SKIPPER runs (3SR-267)). The bilaminates were re-arranged in a random structure (see Appendix C) in run 775 to observe the effect of removing the periodicity from the geometry. (Care was taken to ensure that for any laminate, at an arbitrary distance from the left boundary, the initial wave had passed through approximately the same number of tuff and water laminates ($\pm$ 1) as in the periodic structure.)

Pressure versus mass curves for the two cases at comparable times (about 6.4 μsec) are presented in Fig. 3.3. The mean pressures in the random composite appears to be in qualitative agreement with the 55 $\pm$ 1 kbar result of run 770. It can be observed that the random structure produced an irregular reverberation pattern when compared to the orderly sequence. The damping of the amplitudes of the stress oscillations was aided by the periodic structure. Apparently, the random wave interactions in some individual laminates result in larger departures from the equilibrium values.

The analysis of the results of these calculations is best achieved by dealing with laminate average values of the extensive and intensive variables. Such spatial averaging over the width of a laminate eliminates physically meaningless noise and allows one to study the mean oscillations in each laminate segment of the structure. The pressure oscillations in the twelfth and twentieth water laminates, and the sixteenth tuff laminate, are presented in Fig. 3.4. Once again, the repetitive sequence of the

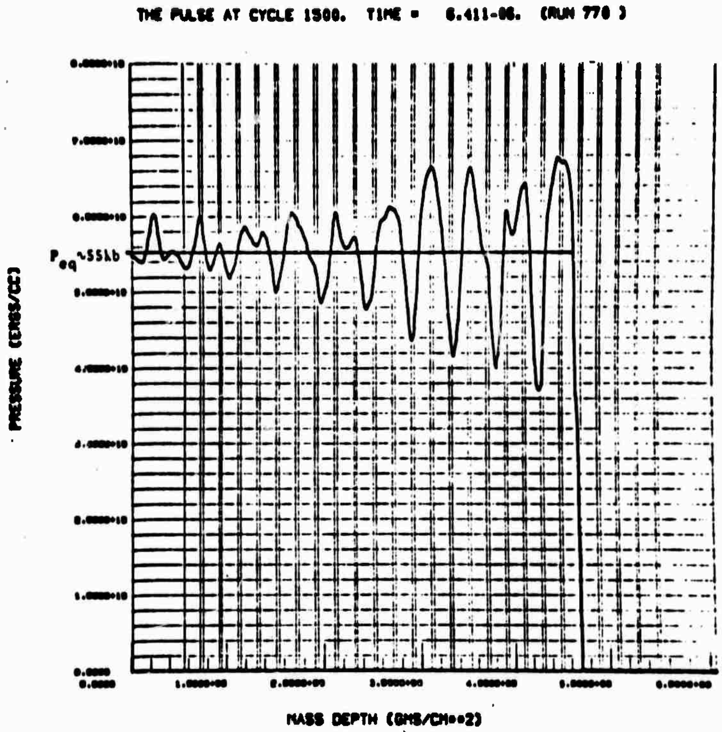

Fig. 3.3(a)

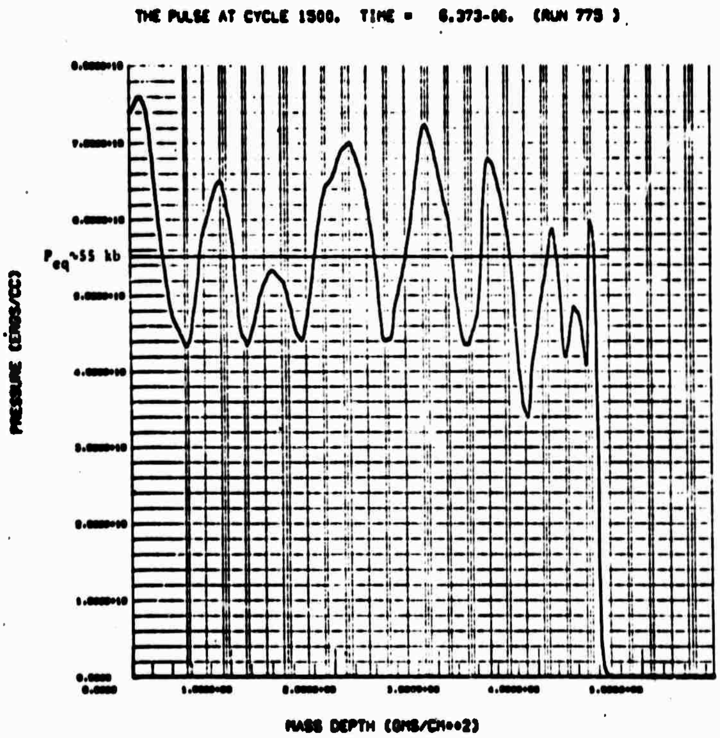

Fig. 3.3(b)

Fig. 3.3--Pressure versus mass in Runs 770 (orderly) and 775 (random). M_W = .15.

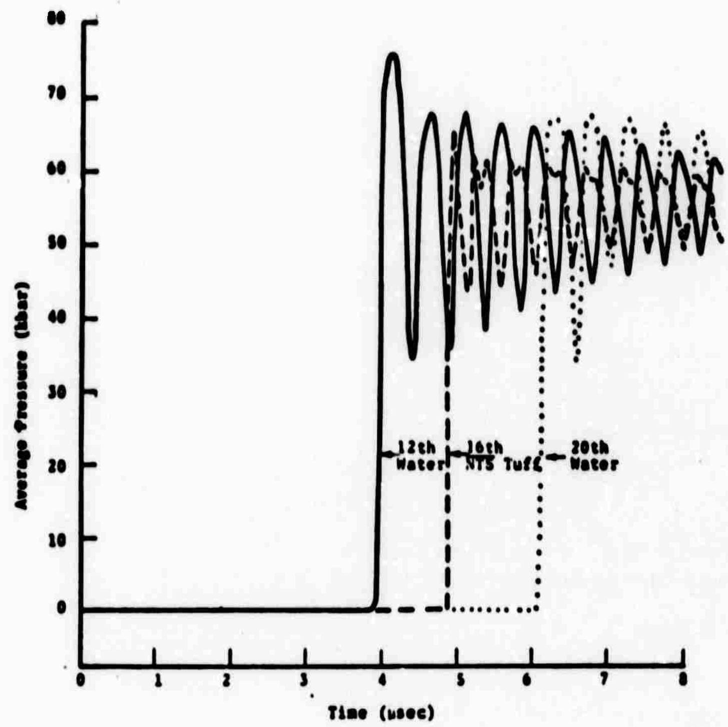

Fig. 3.4(a)
Run 770 (orderly)

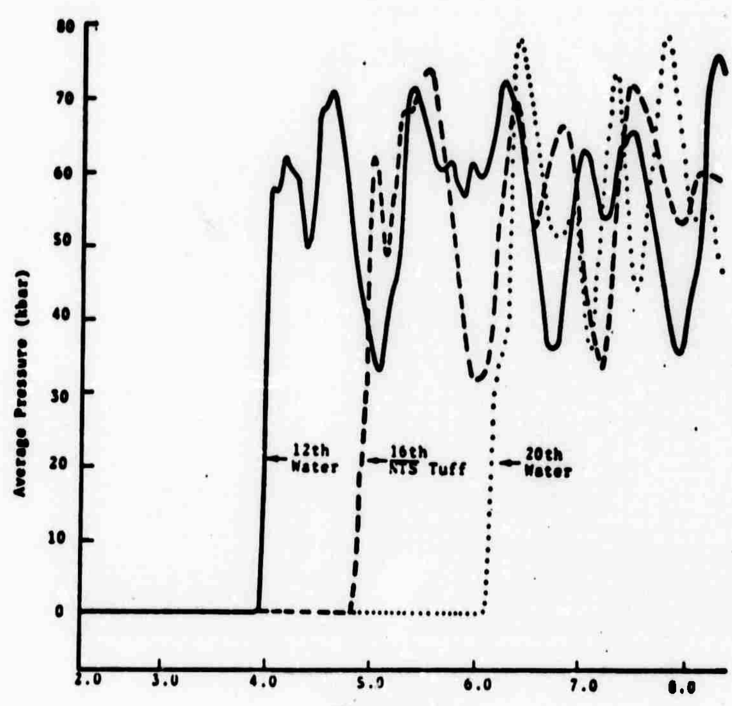

Fig. 3.4(b)
Run 775 (random)

Fig. 3.4--Average pressure, PBAR, as a function of time in the 12th water, 16th NTS tuff and 20th water laminates for Runs 770, 775. Note the oscillatory decay in Run 770.

waves traveling through the water and tuff laminates in the orderly structure is clearly evident. Close agreement in shock arrival times for the two structures is also evident in these plots.

3.3.3 Shock Interactions

A difference between the response in the water and tuff laminates to the initial disturbance can be observed in the initial reverberation sequence in Fig. 3.4a. The water appears to be "smoothly shocked" to a value above the mean in a time period of 0.25 microseconds. The tuff shock is briefer, 0.20 microseconds, and is followed by an abrupt rarefaction.

These results are typical for the sequential bilaminate case. The tuff laminate is first shocked to a value commensurate with a particle velocity comparable to 7.786×10^4 cm/sec (70-80 kbar). Upon interacting with the succeeding water laminate interface, the shock is reflected as an expansion wave.* This implies that a double-shock process occurs in the water which is smoothed over in the average pressure plots.** Double-shocking can be readily detected in the plot of particle velocity vs time (for the twelfth water laminate) in Fig. 3.5a. The initial

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*Although the tuff laminate pressure-time history in Fig. 3.4b does not give as clear evidence of the double shock process, this same phenomena occurs for the random series of laminates. The water particle velocity trace in Fig. 3.5c reveals the characteristic sequence of rapid acceleration and deceleration in the initial reverberation process.

**A small "wobble" in the initial compression wave is barely discernible between 20 and 30 kbar for both water laminates in Fig. 3.4a. A larger "wobble" is observed in the twentieth laminate trace in Fig. 3.4b due to the local bilaminate structure.

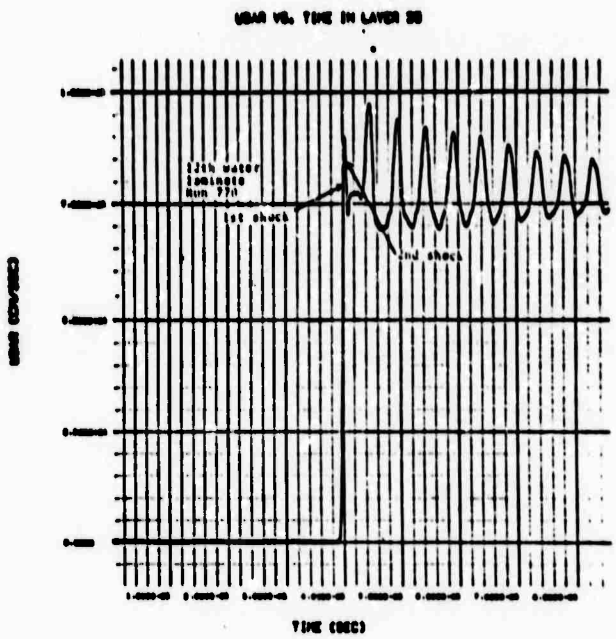

Fig. 3.5(a)--Average particle velocity, UBAR, in 12th water laminate, Run 770.

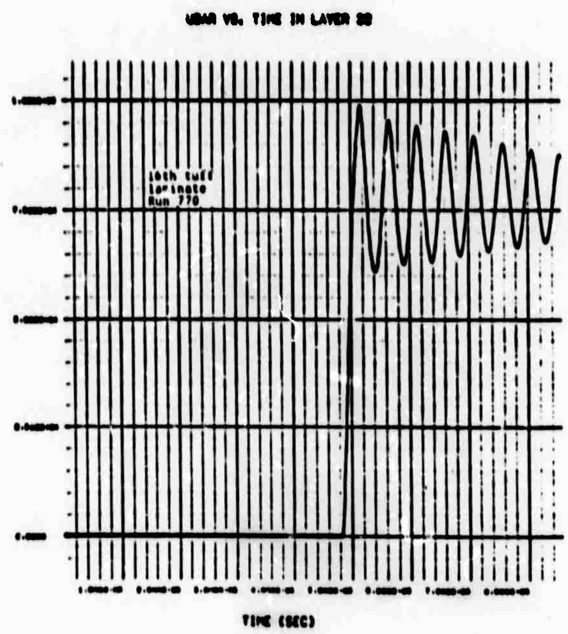

Fig. 3.5(b)--Average particle velocity, UBAR, in 16th tuff laminate, Run 770.

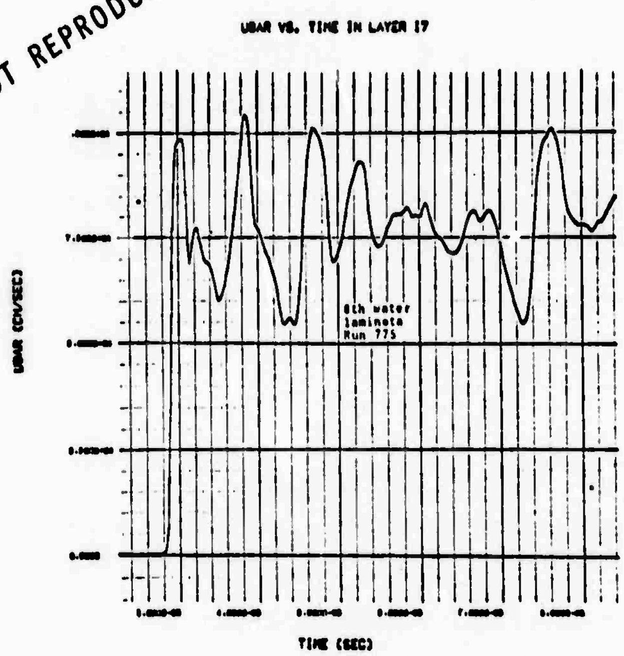

Fig. 3.5(c)--Average particle velocity, UBAR, in 8th water laminate, Run 775. (Random)

shock accelerates the water and the second shock slows it down. A comparison of the time scales in Figs. 3.5a and 3.4a reveals that the initial peak overpressure in the water is achieved <u>after</u> this double interaction occurs.

Examination of the tuff particle velocity trace in Fig. 3.4b shows a single, smooth acceleration of the material, indicating that a single shock compresses the tuff to the peak overpressure.

3.3.4 Equilibrium Conditions - Entropy Signature of the Wave

A significant difficulty in the analysis of the SKIPPER runs is that most variables are always oscillating in each laminate (as in Figs. 3.3-3.5). Thus, definition of an "equilibrium" condition is arbitrary (such as the "eyeball" mean pressure in Fig. 3.3a). The problem is more acute in the case of the random structure. For such geometries, longer run durations would be required to reach conditions approaching equilibrium.

It is well known that the specific entropy is increased as a shock wave passes through a material. Moreover, further increases in entropy will occur only if the material undergoes additional irreversible processes. Thus, specific entropy, as a function of time, in a given laminate should be non-oscillatory.

It has proven to be extremely helpful to study the entropy production in the SKIPPER runs. The entropy, for tuff or water,* is given by

$$S_i = C_{V_i} \left[\ell n \frac{T_i}{T_0} + \int_{V_{0_i}}^{V_i} \frac{G_i(V)\ dV}{V} \right] \qquad (3.20)$$

*The expression for entropy is derived in Appendix C. $G_i(V_i)$ is the Gruneisen ratio of the ith material, assumed to explicitly depend on V_i.

and is readily calculated for each thermodynamic state.

Entropy production in the laminates has been edited for runs 770, 775, and the following major observations should be noted:

- Entropy production in the water laminates is effectively limited to the first double-shock interaction.
- Entropy production in the tuff laminates occurs not only at the initial shock, but continues to rise due to "shocklets" reverberating in the tuff.
- The tuff entropy rise asymptotically approaches a limiting value.
- These observations are appropriate for both the random and periodic arrangement of laminates.

These results may be inferred from the plot of the total laminate entropy versus time for typical water and tuff laminates in Fig. 3.6. The water entropy rises to a value roughly commensurate with a shock of about 35 kbar even though the equilibrium pressure is about 55 kbar. A slight decrease in entropy follows the initial rise due to the action of the artificial viscosity "pulling" the water along with the tuff.

The tuff laminate, on the other hand, exhibits an almost continuous rise in the entropy after the initial shock wave passes through. One may also note that an asymptotic limit is apparently being approached.

These results are typical for the laminate entropies in both runs 770 and 775. They do mask the details of the interaction process, however, because of the summing over all zones in a given laminate. Fig. 3.7 gives the entropy rise in particular zones of tuff and water laminates in

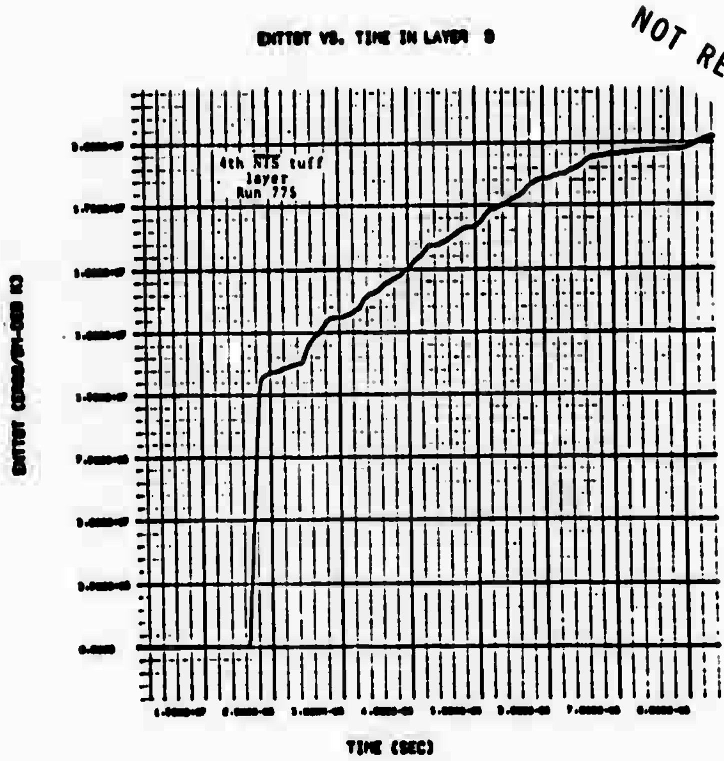

Fig. 3.6(a)
Tuff laminate

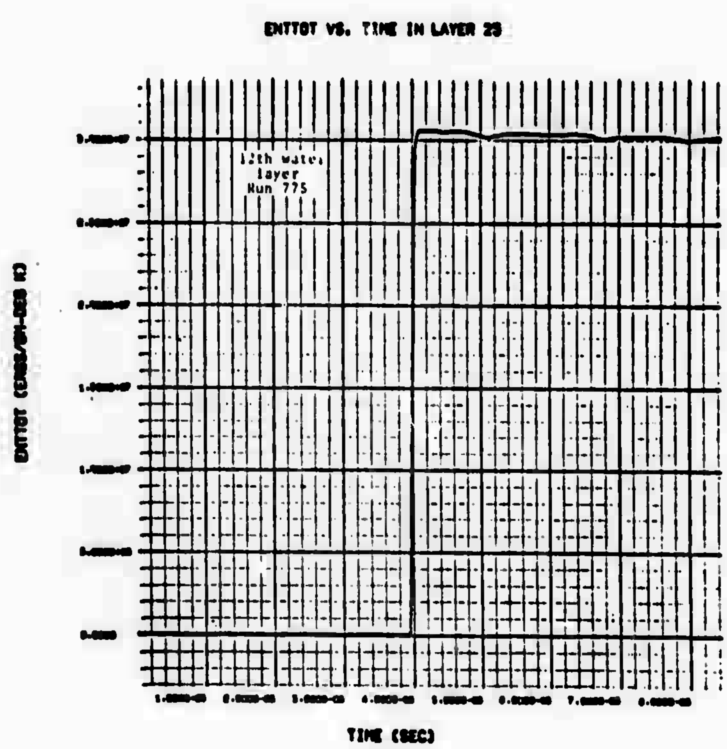

Fig. 3.6(b)
Water laminate

Fig. 3.6--Total entropy (ENTOT) in water and tuff laminates as a function of time.

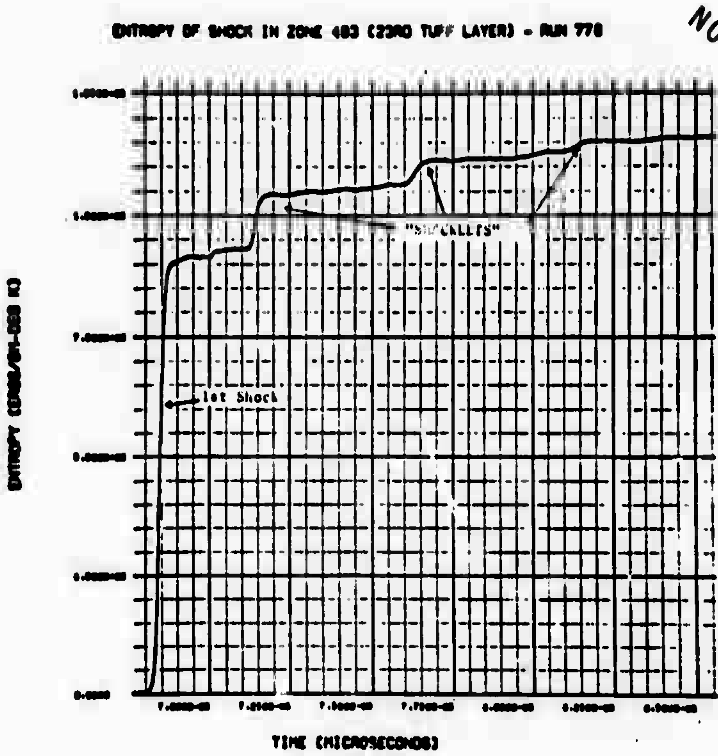

Fig. 3.7(a)
Tuff zone

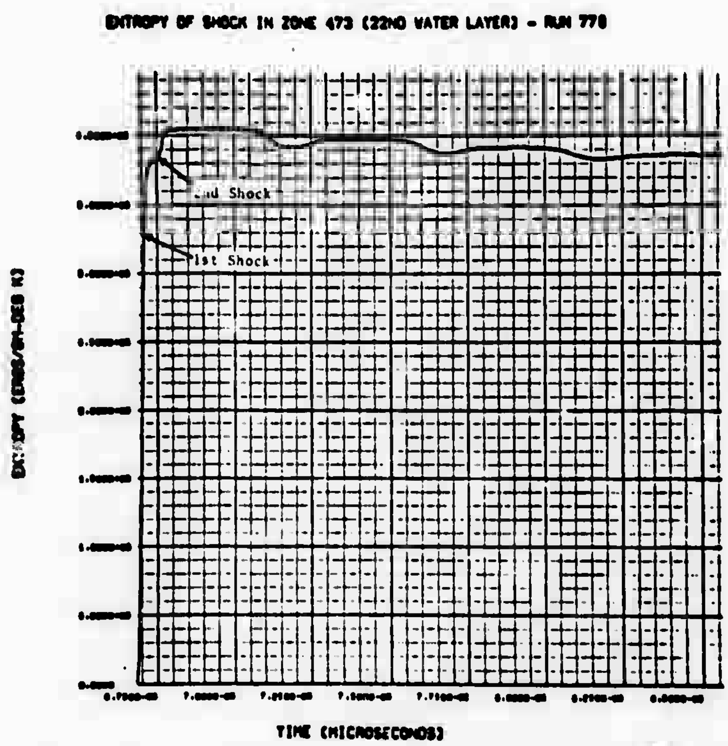

Fig. 3.7(b)
Water zone

Fig. 3.7--Entropy in individual NTS tuff and water zones.

run 770. The double shock in the water zone is indicated by the two-step entropy rise in the first 0.16 μsec. Most of the entropy gain is due to the first shock. (It has been verified by calculations of double shock states that entropy rises of the order of 5×10^6 ergs/g-°K result from initial shocks between 20 and 30 kbar. The second shock to about 55 kbar results in much smaller entropy increases of about 5 percent of the initial entropy). Although high velocity and pressure gradients exist in the water laminates in the wake of the two shocks, additional shock waves do not develop. The slight decreases in entropy in this particular zone are due to the action of the artificial viscosity in pulling the water to keep up with the tuff.*

Entropy rises in the tuff zones are exemplified by the entropy-time trace in Fig. 3.7. The first shock is followed by three identifiable "shocklets". An additional gain is also observed that is attributable to the effective "slowing down" of the tuff by the artificial viscosity.

Based on these observations, the passage of a shock wave disturbance through the bilaminate geometries could be expected to leave an entropy "signature" in the water, that remains invariant with time. The structure of this signature results from the differences in the initial shock wave intensity encountered by succeeding laminates. A corresponding equilibrium signature in the tuff would be present once a truly steady wave disturbance is established.**

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*The double-shock generally results in the water being decelerated to a particle speed less than the imposed boundary condition. Hence, dynamical equilibration under the influence of high velocity gradients brings the artificial viscosity into play in the numerical calculations.

**A duplicate run of 770 was conducted with twice the zoning to verify that the entropy signature was not dependent on zone size (five zones per laminate in run 770). This run (No. 780) produced essentially identical results and is discussed in Appendix C.

Figure 3.8 is a plot of average entropy values in water and tuff laminates calculated in run 770. From the entropy signature in the water, it is possible to calculate an equilibrium value of the water entropy (S_W (7.786 × 10^4, .297) $\simeq$ 4.8 × 10^6 ergs/gm-°K). This is not possible in the tuff, since true equilibrium has not yet been achieved in the SKIPPER calculations.

A comparison of the entropy signatures in the periodic and random laminate geometries is presented in Fig. 3.9. It is clear from these values that although the deviation from the mean value is greater in the randomly spaced laminates, the actual magnitude of the mean entropy is (effectively) the same. Thus, the mean thermodynamic quantities are independent of the laminate geometry.

The equilibrium tuff entropy for both runs 770 and 775 may be computed, from Eqs. (3.17) - (3.19). Using a value of 4.82 × 10^6 ergs/gm-°K for S_W, the equilibrium tuff entropy is 1.938 × 10^6 ergs/gm-°K.

Such an entropy (or energy) partition results in a shock pressure of 56.16 kbar, a value which is slightly higher than the "eyeball" average of 55.0 kbar (see Fig. 3.4). This result is not surprising, since true equilibrium has not yet been achieved for these numerical step-pulse experiments. The initial shock wave is observed to propagate at a fairly constant speed (see Appendix C) but the interaction zone has not been completely established. (One may refer to this type of shock propagation as quasi-steady.) The observation that the water attains its equilibrium entropy prior to overall equilibration is therefore a valuable result. SKIPPER experiments could be limited to less than a microsecond real-time durations, yet still provide enough information to predict the equilibrium state.

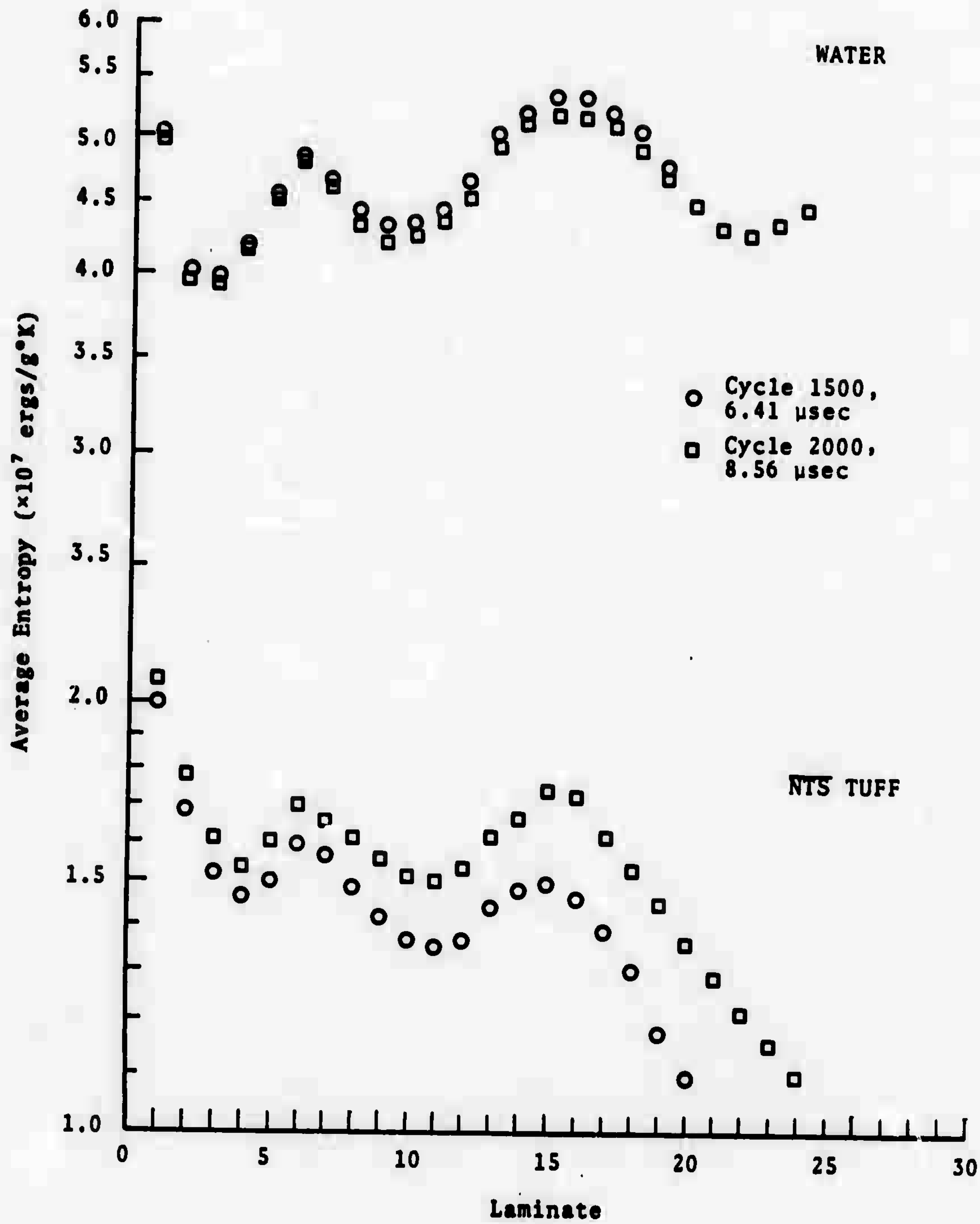

Fig. 3.8--The entropy signature of the pulse in the orderly bilaminate sequence in Run 770. The average entropy is plotted at two times for each laminate.

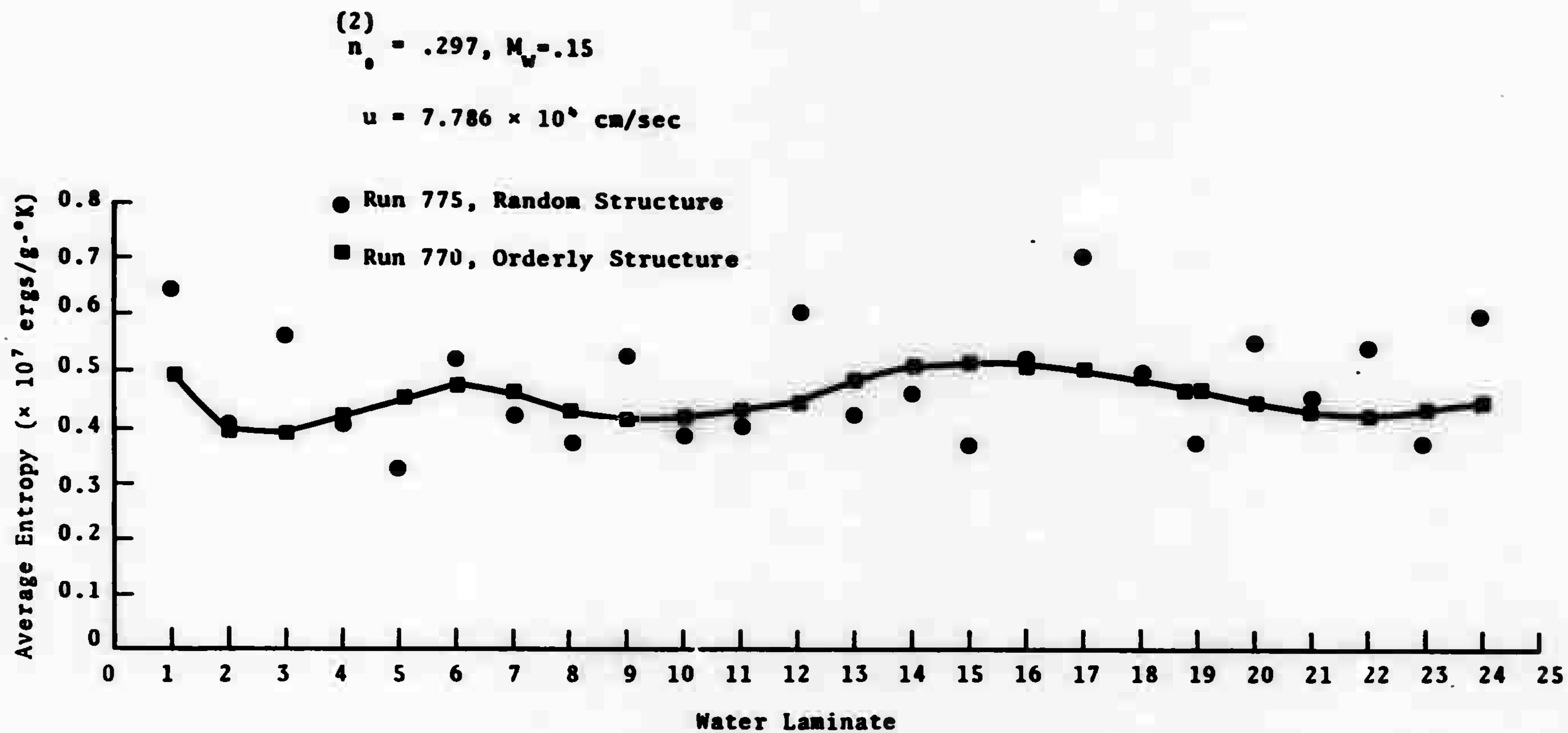

Fig. 3.9--A comparison of the water entropy signatures in Run 770 (orderly) and Run 775 (random). (t ∿ 8 μsec)

The reason for the relatively rapid equilibration of the water can be traced to the large disparity in the sound speeds between the tuff and the water at pressures above 40 kbar (see Appendix B). A high sound speed in the water precludes the formation of shock waves whereas shock waves are possible in the tuff laminates.*

3.3.5 Double Shock Entropy Function

The remainder of the SKIPPER runs (785, 800, 805) were conducted to determine the double-shock entropy function, $S_W(u, n_0^{(2)})$. These cases have provided the equilibrium entropy levels in water laminates at shock velocities of 1.25 and 2.2×10^5 cm/sec (see Table 3.1). The water entropy signatures of each run are presented in Fig. 3.10.

A detailed theory of the shock-reverberation process is not required for the purposes of the present study. It is possible to choose an analytical form for $S_W(u, n_0^{(2)})$ that can be fit to the mean values of the entropy signatures. It is clear from the schematic of the basic wave interactions (Fig. 3.1) that one may specify the upper and lower bounds to the water entropy to be given by the values corresponding

---

*In a given laminate, the overall wave train velocity of the reverberations is comparable to the shock speed. Thus, pressure disturbances will propagate supersonically, whenever

$$\frac{U \pm u}{c} > 1 .$$

For water, a typical sound speed in runs 770 and 780 ($u = 7.786 \times 10^4$ cm/sec), is $c = 4.4 \times 10^5$ cm/sec, whereas the shock velocity is about $U = 3.7 \times 10^5$ cm/sec. Thus, when a pressure disturbance moves "against" the overall flow of the water at a relative speed of $U + u = 4.48 \times 10^5$ cm/sec, the flow is barely supersonic and only isentropic propagation of pressure pulses result. The situation for tuff, however, is that the disturbance speed is twenty percent greater than the sound speed; enough to induce weak shocks.

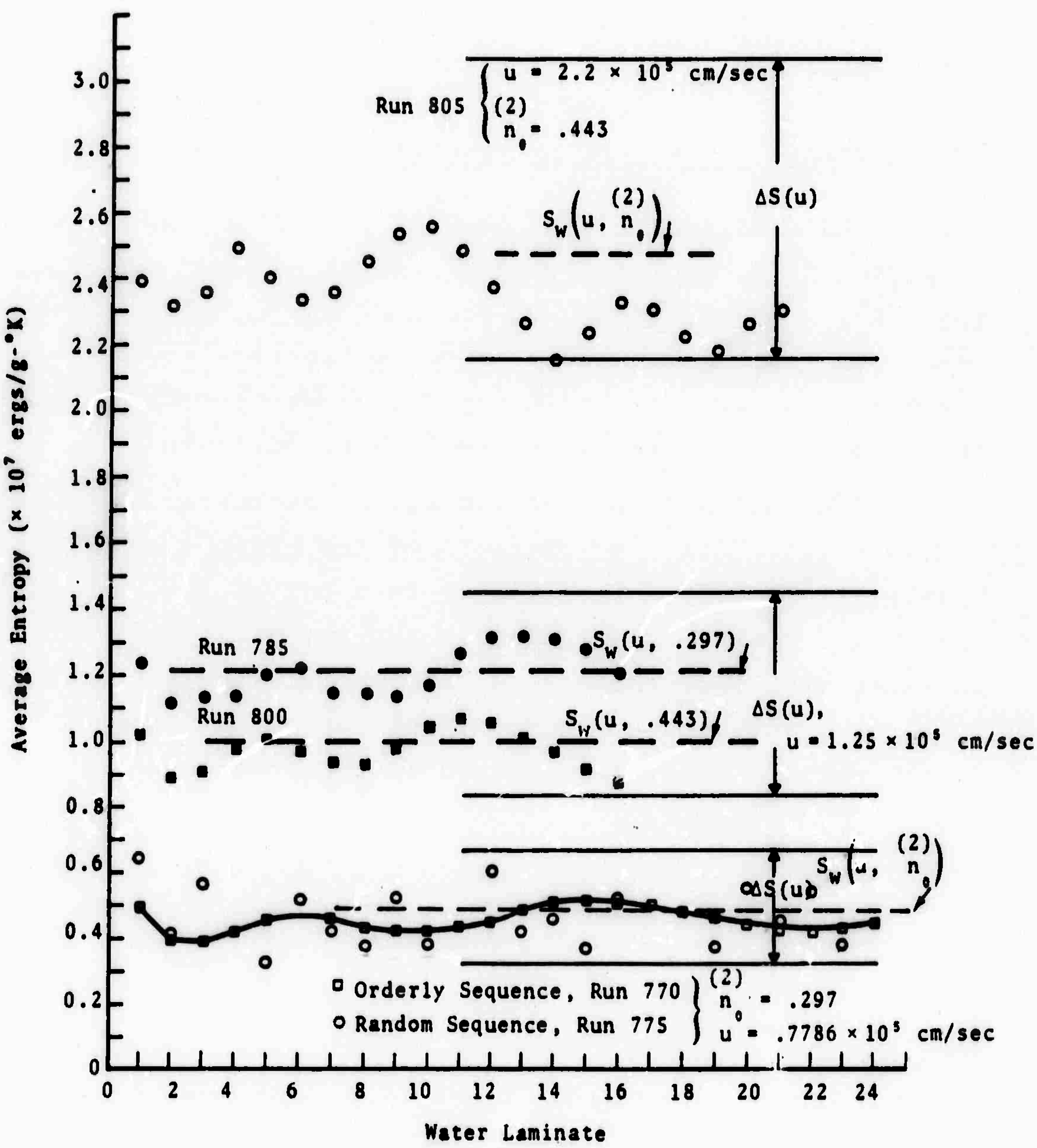

Fig. 3.10--Entropy signatures of Runs 770, 775, 785, 800 and 805.

to shock pressures, p_{W_2} and p_{W_4} respectively.* It can be seen in Fig. 3.10 that, with one exception, the entropy levels in randomly placed laminates fall within this range. Consequently, $S_W(u, \overset{(2)}{n}_0)$ has been fit to an analytic form,

$$S_W\left(u, \overset{(2)}{n}_0\right) = S_{min}(u) + \Delta S(u)\left\{g\left\{\overset{(2)}{n}_0\right\}\left[1+\left\{C_1\,\overset{(2)}{n}_0\left(1-\overset{(2)}{n}_0\right)^2\right\}\left(\frac{u-u_c}{u_c}\right)\right]\right\} \quad (3.21)$$

where

- $S_{min}(u)$ is the minimum water entropy for a given particle velocity (i.e., $\left(S\ p_{W_4}\right)$ in Fig. 3.1)
- $\Delta S(u)$ is the entropy range for a given particle velocity: $\left\{\left(S\ p_{W_2}\right) - \left(S\ p_{W_4}\right)\right\}$
- $\left[1 \geq g\left(\overset{(2)}{n}_0\right) \geq 0;\ g(0) = 1,\ g(1) = 0\right]$
- C_1 and u_c are constants (to be fit to SKIPPER results).

It was found convenient to represent $g\left(\overset{(2)}{n}_0\right)$ as a cosine of a cubic in $\overset{(2)}{n}_0$,

$$g\left\{\overset{(2)}{n}_0\right\} = \frac{1}{2}\left\{1 + \cos\left(a_1\left(\overset{(2)}{n}_0\right) + a_2\left(\overset{(2)}{n}_0\right)^2 + a_3\left(\overset{(2)}{n}_0\right)^3\right)\right\}, \quad (3.22)$$

$a_1 = 3.43907$
$a_2 = 5.41630$
$a_3 = -5.71378$

and $C_1 = 4.25$, $u_c = 1.25 \times 10^5$ cm/sec

This expression for $S_W(u, \overset{(2)}{n}_0)$ indicates significant reductions of water entropy compared to those achieved in a shock of the same strength in pure water (see Fig. 3.11).

It should be stressed that Eq. (3.21) is not intended as a general solution to the problem, but rather as a useful relationship for studying the energy partition effects which

*The second shock in the double-shock interaction is very weak compared to the first and has been neglected.

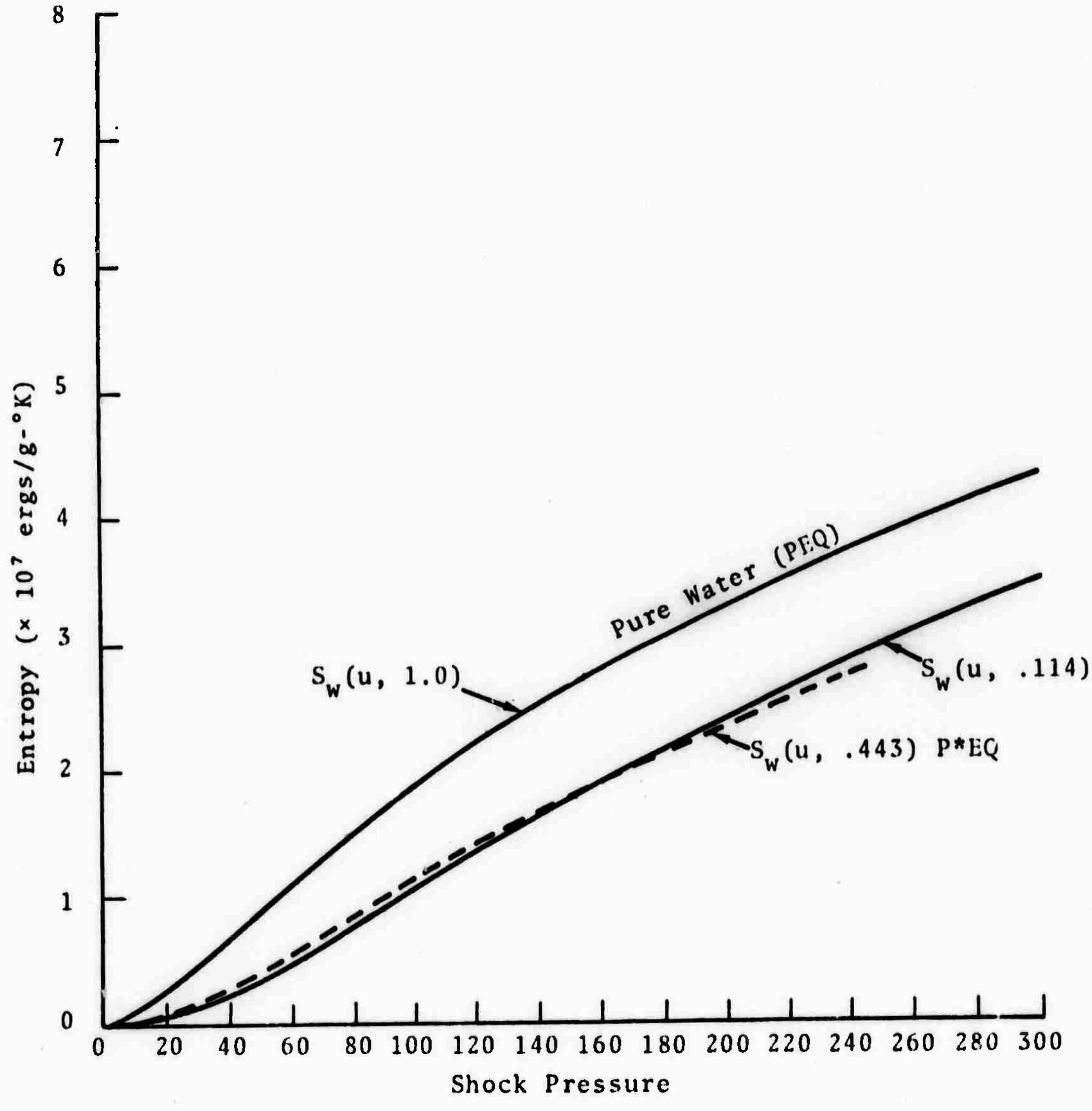

Fig. 3.11--Water entropy as a function of shock pressure in the two pressure equilibrium formulations (PEQ, P*EQ). Interesting to note is that in the Pressure-Entropy plane, S_W is (approximately) independent of water mass or volume fraction.

result from consideration of shock reflection phenomena in geologic composites. Thus, only the partition results of the P*EQ model are physically meaningful.

The values of $S_W(u, n_0^{(2)})$ from Eq. (3.21) are compared to the actual calculations in Fig. 3.10. P*EQ shock states, computed from these values of the equilibrium water entropy, are summarized in Table 3.2. Also given in Table 3.2 are the eyeball averages of pressure in the eighth water laminate as well as the shock pressure computed from the observed shock front velocity (see Appendix C). Significantly, the P*EQ value is in better agreement with the latter shock pressure. This is a result of the quasi-steady nature of the shock fronts. True equilibration, wherein the initial shock wave is followed by a reverberation region of (time-invariant) constant extent, has only been asymptotically approached in the present series of SKIPPER runs.

TABLE 3.2

SKIPPER Series – P*EQ Comparison

Run	(1) n_0	(2) n_0	M_W	$u \times 10^5$, cm/sec	$\bar{p}$, kbar	$\bar{\bar{p}}$, kbar	p_{P*EQ} kbar	$\bar{T}$, deg K	T_{P*EQ} deg K
770, 775, 780	.703	.297	.15	.7786	55	57	56.15	501	510
785	.703	.297	.15	1.25	100	109.5	106.9	710	737
800	.557	.443	.25	1.25	90	95	92.8	655	667
805	.557	.443	.25	2.2	208	218	213.5	1220	1260

$\bar{p}, \bar{T}$ = "eyeball" average in 12th water laminate

$\bar{\bar{p}}$ = shock pressure computed from ρ_0 Uu (U from Appendix C)

3.4 RESULTS - SATURATED MIXTURES

3.4.1 Shock States - Mechanical

The loci of shock states in the pressure-volume plane for the three models are presented in Fig. 3.12 for water mass fractions of .05, .15, and .25. In this representation, only small differences exist between the PTEQ, P*EQ, and PEQ formulations. It may be noted that the PTEQ Hugoniot generally lies to the left of the P*EQ and PEQ curves. That is, the assumption of thermal equilibrium results in a more compressible mixture wherein the shock-heating (or entropy rise) is maximized* at a given shock velocity.

All three of the mixture models under evaluation, when utilized with the poreless $\overline{\text{NTS}}$ tuff and water equations of state (Appendix B), yield physically realistic values of the shock Hugoniots for saturated tuff mixtures. This is evident in Fig. 3.13 wherein three PTEQ mixture Hugoniots (M_w = .1, .2, .3) are compared to the data reported by Lysne[11], Rosenberg[5], and Lombard[12]. Due to the almost coincident curves in Fig. 3.12, the PEQ and P*EQ Hugoniots are not shown in Fig. 3.13. The "spread" in experimental data is larger than that given by the three formulations.

For reference purposes, the water and (dry) "poreless" $\overline{\text{NTS}}$ tuff Hugoniots are also presented in Fig. 3.13. These are compared to the water data of Rice and Walsh[13], Lysne[11], and the compacted tuff Hugoniots measured by Bass[14] and Shipman, <u>et al</u>.[15].

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*The entropy produced by a shock wave at a given velocity is proportional to the area between the Rayleigh Line and the Shock Hugoniot. Thus, a consistently "more compressible" mixture will have higher entropy levels for a given shock velocity. Note that since the pressure equilibrium formulations are not in thermal equilibrium, there is no a priori reason to expect that all cases will result in lower entropies than the PTEQ model.

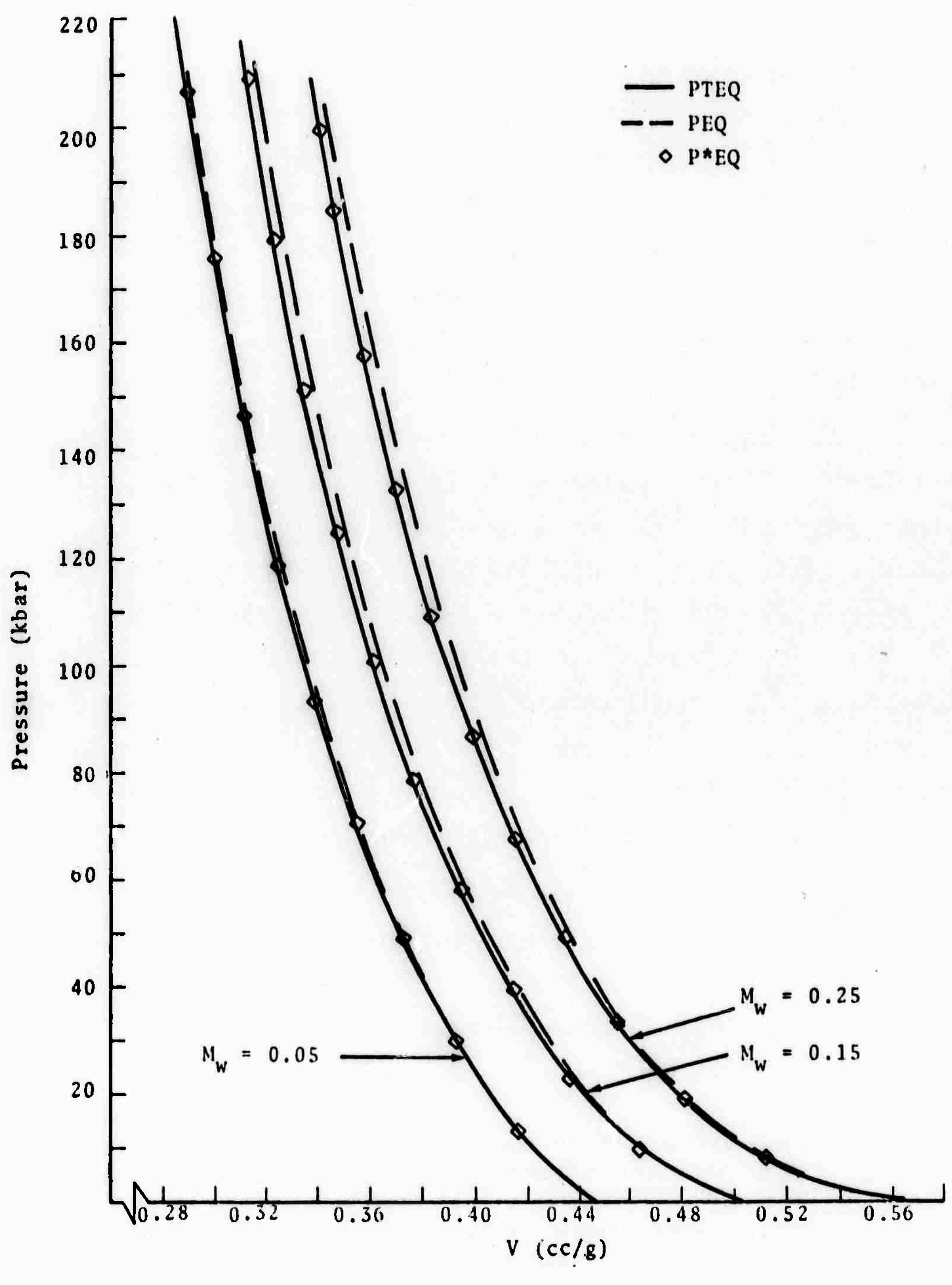

Fig. 3.12--The Hugoniots for $\overline{\text{NTS}}$ tuff/water mixtures (M_W = .05, .15, .25) predicted by the PTEQ, PEQ, and P*EQ models.

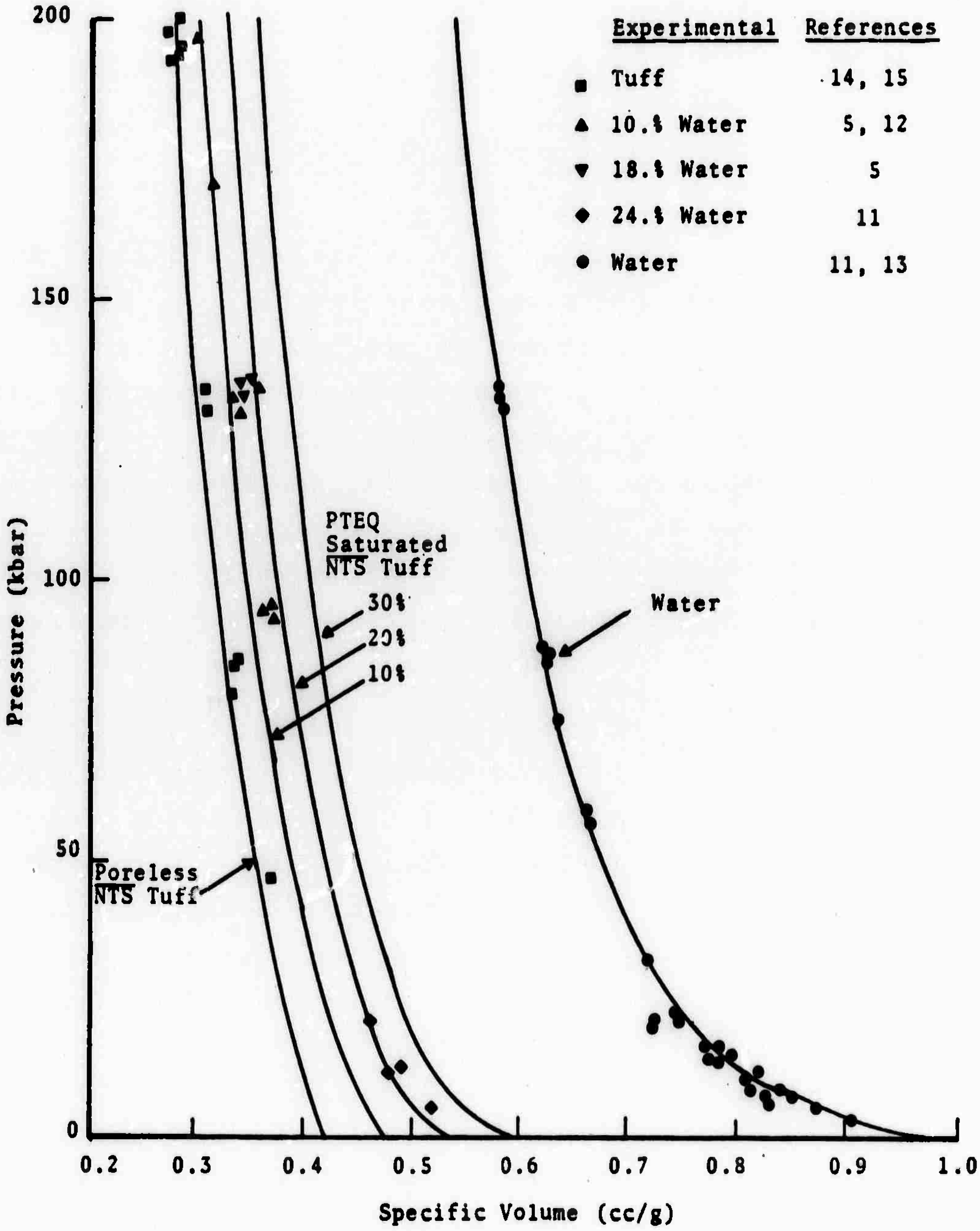

Fig. 3.13--A comparison of the PTEQ Hugoniots to experimental results (p-V plane).

Experiments are generally designed to measure particle and shock velocities, respectively given by

$$u = \sqrt{(p + p_0)/(V_0 - V)} \tag{3.22}$$

and

$$U = \left\{ \frac{V_0}{(V_0 - V)} \right\} u \tag{3.23}$$

The small differences in the p-V states of the three models results in similarly close agreement in the U-u plane. The PTEQ and PEQ shock velocities are plotted versus u in Fig. 3.14. P*EQ values are plotted as clear diamonds. At a given particle velocity the spread in the three theoretical values is less than 3.0 percent of the shock velocity. Moreover, a cross-over in the tuff and water curves at about $u = 3.0 \times 10^5$ cm/sec results in a regime where the water fraction plays a minor role in the shape of the theoretical U-u curve.

The available results of laboratory experiments conducted with various water mass fractions of saturated tuffs are also plotted in Fig. 3.14. It is obvious from these results that the $\overline{\text{NTS}}$ poreless tuff formulation may be an oversimplification of the tuff behavior.* However, there is no definitive trend in the data, and the scatter of the experimental points is not conducive to generating additional equations of state for the different tuffs. The poreless $\overline{\text{NTS}}$ model is qualitatively consistent, and its utilization in the study of partitioning effects is not compromised by this situation. Specific tuffs could be treated with all three of the mixture models, should a different tuff equation of state be specified.

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*It is likely that for some of the "saturated" data $n_0^{(3)} \neq 0$.

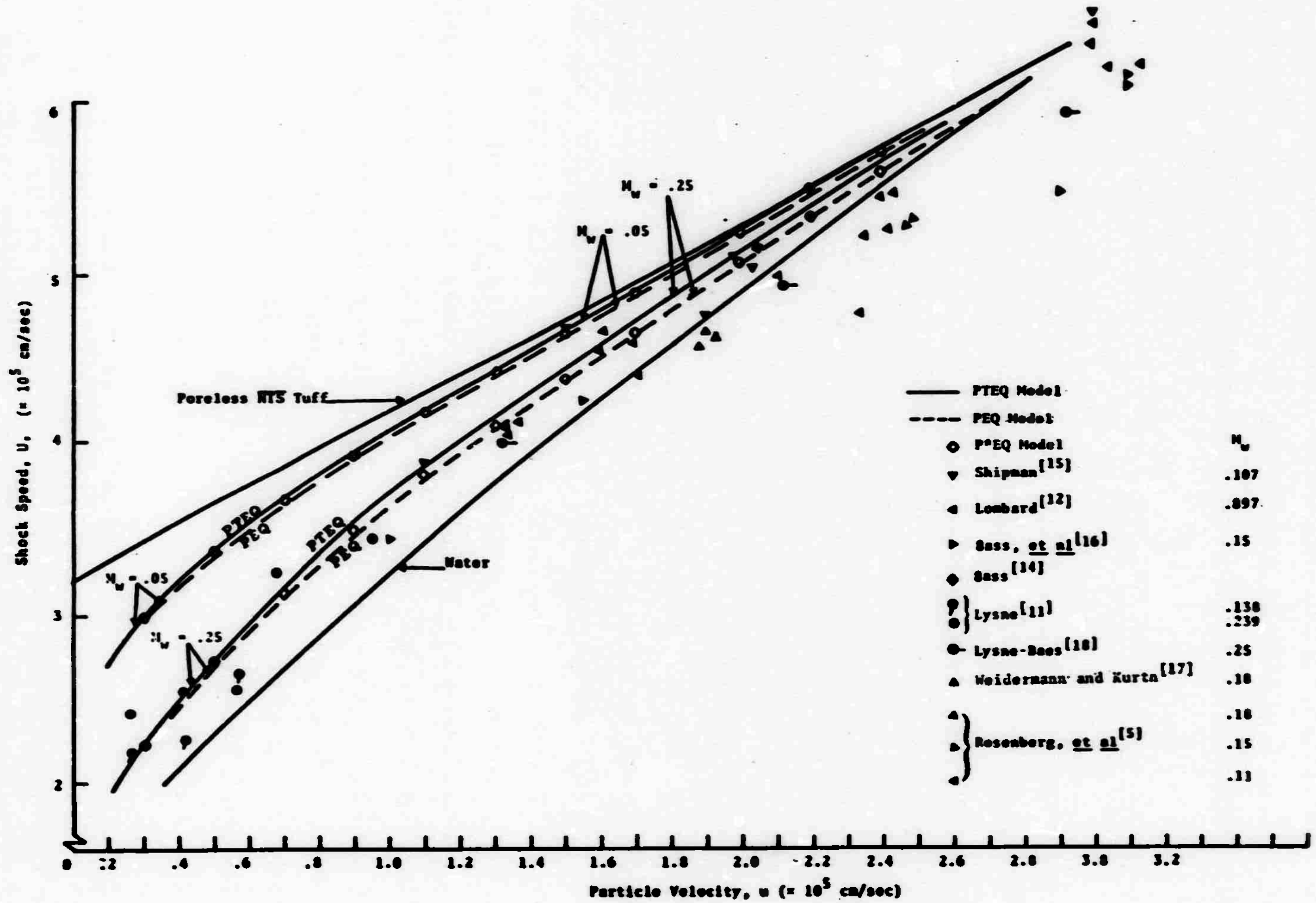

Fig. 3.14--Shock velocity, U, as a function of particle velocity, u, for $\overline{\text{NTS}}$ tuff/water mixtures. Laboratory experimental results are also shown.

From the results presented above, it is possible to calculate the sum of the mechanical interaction terms appearing in the constituent* momentum conservation relations, Eq. (2.35). For convenience, let us introduce the mechanical interaction stress acting on the constituent $\overset{(i)}{p}_*$,

$$\overset{(i)}{p}_* \equiv \int_V \rho \overset{(i)}{\beta} \, dV \qquad (3.24)$$

This stress is that which is exerted on a mixture constituent in the shock-disturbance region to achieve complete mechanical equilibrium ($u_i = u$ and $p_i = p$ for all i). Substituting this expression into Eq. (3.12);

$$\overset{(i)}{p}_* = \overset{(i)}{n}_0 \left\{ \left(\rho_{0_i} Uu + p_0 \right) - \frac{\overset{(i)}{n}}{\overset{(i)}{n}_0} p \right\} \qquad (3.25)$$

Since the values of $\overset{(i)}{p}_*$ are determined by the mechanical Hugoniot states (such as those presented in Figs. 12-14), one can anticipate only minor differences in the interaction stress for the three models. This is apparent in Fig. 3.15 where the ratio of $\overset{(i)}{p}_* / p$ in the water is plotted vs shock pressure for $M_W = 0.15$. The overall value of $\overset{(W)}{p}_*$ is negative, implying that the water does mechanical work on the tuff in the shock zone.** This could be anticipated from a comparsion of the p vs u plots for tuff and water (see Fig. 3.1). Water in its pure state has a higher particle velocity for a given shock pressure. In a mixture it would tend to pull the tuff to bring it up to speed. It is evident that the interaction terms are an order of magnitude less than

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*The application of this equation to the case of laminates perpendicular to the direction of wave propagation assumes that the dilatation ratio, $\overset{(i)}{n} / \overset{(i)}{n}_0$, is a value averaged over the characteristic dimensions of the entropy signature.

**This is not in contradiction with the SKIPPER code results cited in Section 3.3.1, where the water is "pulled" by the tuff after the double shock process occurs. The overall interaction includes the initial double shock.

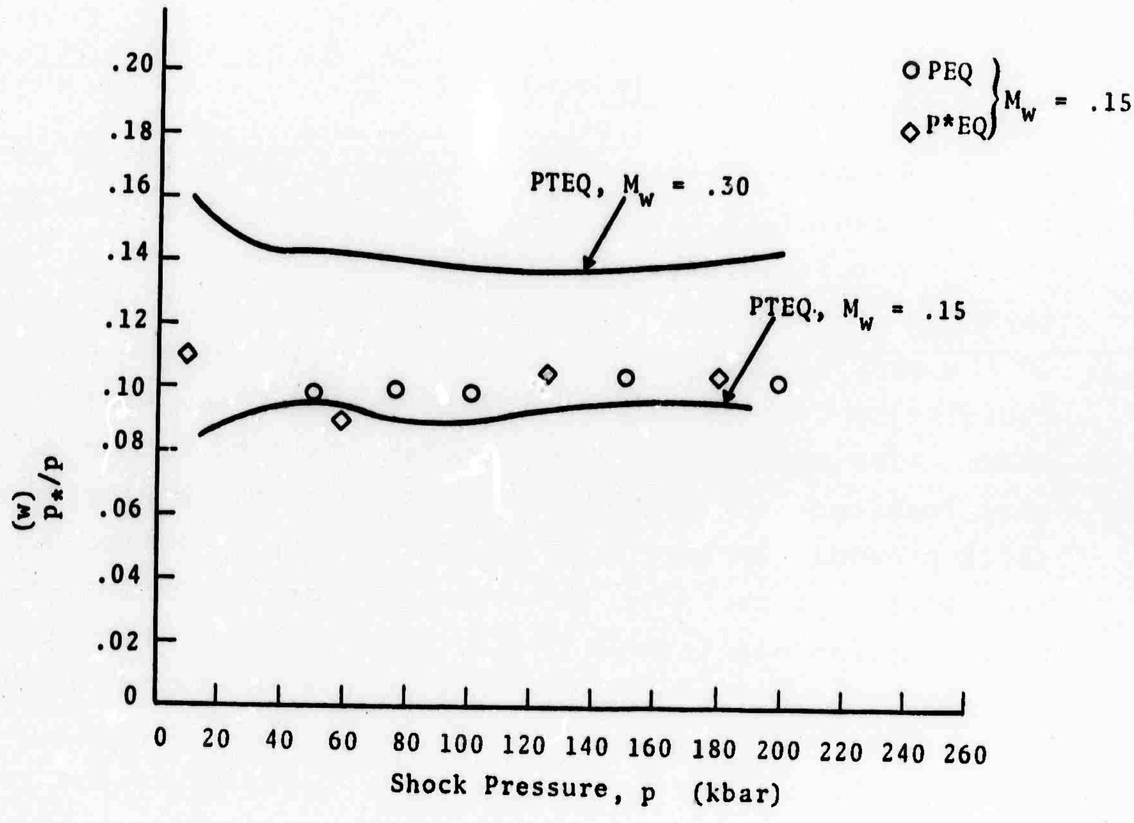

Fig. 3.15--The ratio of the mechanical interaction stress exerted by the water to the shock pressure, $p_*^{(w)}/p$, plotted versus shock pressure.

the mean pressure. They indicate the average rate at which momentum must be transferred, per unit area, between the constituents to achieve dynamic equilibrium. Thus, if a theory (such as TINC) models the interaction terms correctly, it would be possible to actually calculate the thickness of the disturbance (e.g., the initial shock plus an equilibration region moving with the shock).

3.4.2 Shock States - Thermal

The major differences between the three models arise from the manner in which the internal energy rise across the shock front is partitioned between the constituents. This is a direct result of the constitutive relations utilized in the pressure equilibrium models in place of the thermal equilibrium constraint employed in the PTEQ equation of state. The ratio of internal energy absorbed by the water to that imparted in the overall composite is shown plotted versus shock pressure in Fig. 3.16 for three mixture ratios of tuff and water. At the lower pressures, water is considerably more compressible than the tuff. As a result, the water absorbs much more of the internal energy in the two pressure equilibrium formulations. In the PTEQ mixtures, most of this internal energy is lost to the tuff by conduction. Hence the water experiences a markedly lower energy rise in the PTEQ states.* At higher pressures the water is less

*The five percent water mass-function case indicates a net energy loss in the water component at very low shock pressures. This is consistent with the unusual shape of the compression energy integral for water (see 3SR-267) which provides a negative contribution to the total internal energy for $.675 \leq V_w \leq 1.008$. Thus, if the thermal contribution is significantly reduced (by conduction to a tuff heat sink), the overall internal energy of the water could very well be negative.

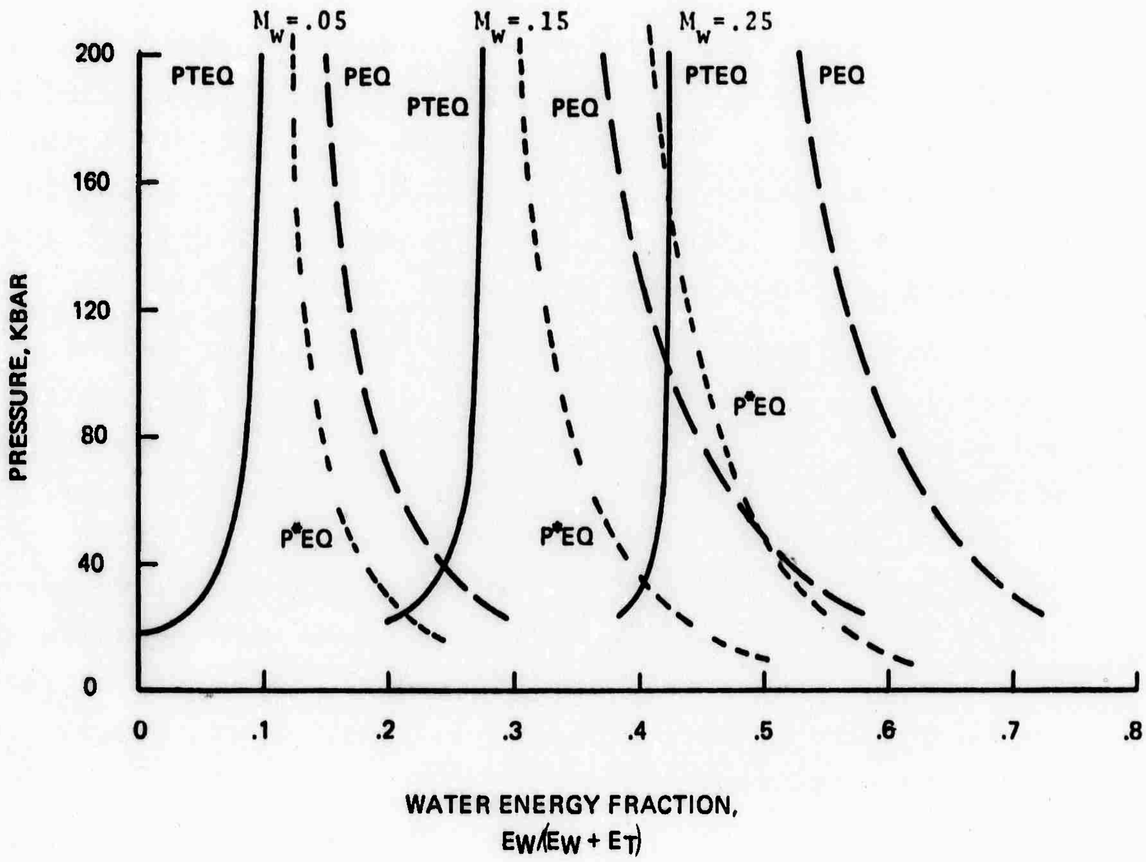

Fig. 3.16--Energy partition in the NTS water/tuff mixtures as a function of shock pressure. The fraction of internal energy in the water is shown for the three models under investigation.

compressible and the energy partition varies more slowly with pressure. This tends to reduce the effect of the thermal equilibrium assumption on the energy partition (relative to PEQ and P*EQ) but significant differences remain.

The principal result of the energy partitioning is the dramatically different shock temperatures predicted by the three models. Shock temperature versus pressure for three PTEQ mixtures and the pure components are shown in Fig. 3.17. The latter curves represent the PEQ shock temperatures of the (isolated) mixture constituents.*

As one might anticipate from the energy partition curves in Fig. 3.16, the P*EQ model is (generally) intermediate between the PTEQ and PEQ models in the temperature-pressure plane. The 15 percent water mass fraction mixture is a typical case. P*EQ shock temperatures are plotted versus pressure in Fig. 3.17 (clear diamonds). They are higher in the tuff and lower in the water when compared to those of the pure materials (PEQ model). They still bracket the PTEQ values, but the spread in constituent temperatures is markedly reduced.

It is clear that the water temperatures at a given shock pressure, are lower in the PTEQ and P*EQ mixtures than in pure water. Therefore, the prospect of a shock induced,

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*These curves differ from those presented previously (3SR-267) due to the modifications in the thermal equations of state (see Appendix B).

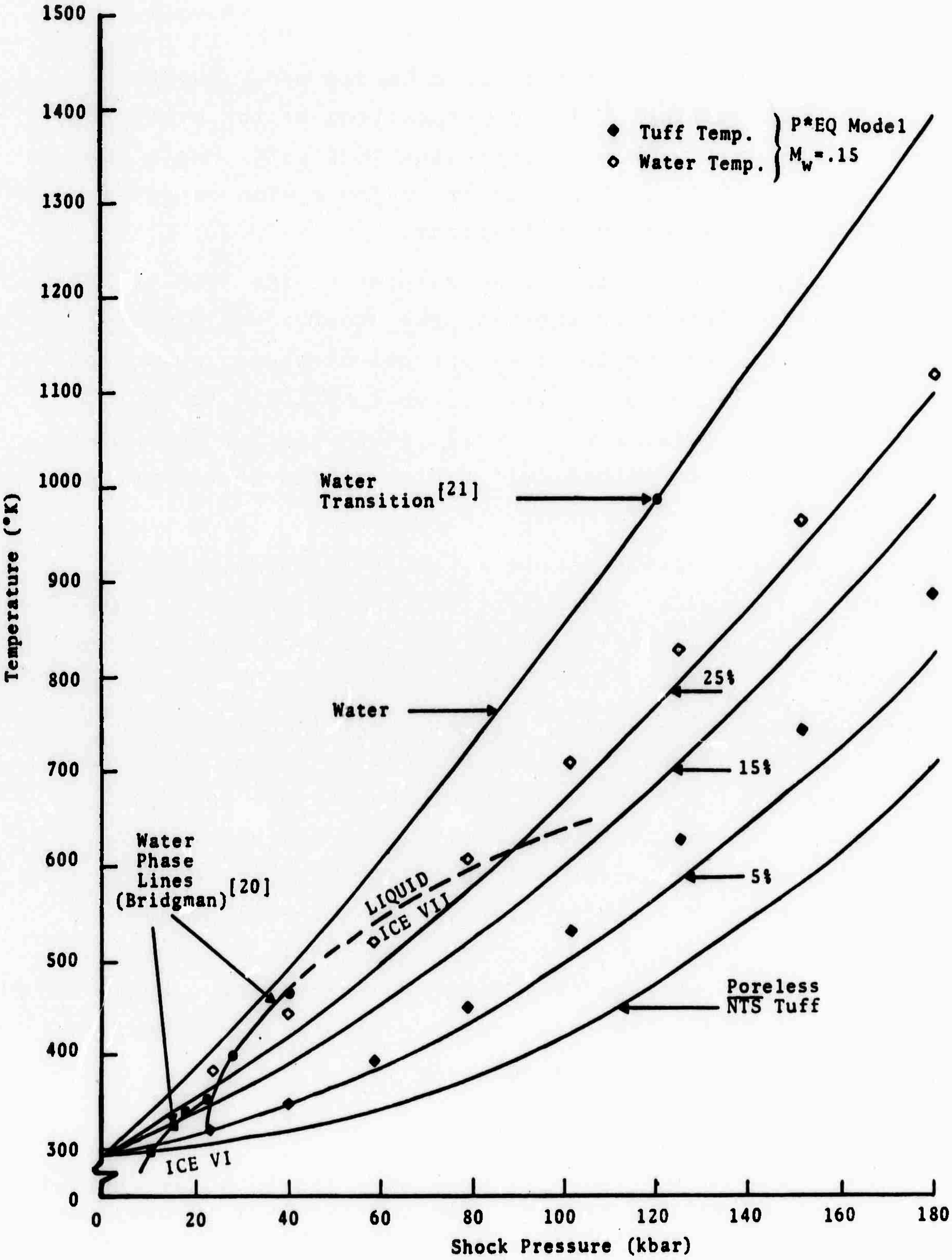

Fig. 3.17--Shock temperatures calculated from the PTEQ, PEQ and P*EQ models. Solid curves depict PTEQ temperatures for indicated M_w values.

liquid-ice phase transition* is enhanced under the PTEQ and P*EQ assumptions. The superposition of the extrapolated phase line in Fig. 3.17 illustrates that water phase changes in PTEQ and P*EQ mixtures may occur for a wide range of shock pressures and water concentrations.

The increased tuff temperatures on the PTEQ and P*EQ Hugoniots, relative to those of the shock temperatures of the isolated tuff employed in our calculations, would inhibit crystalline quartz transition to Stishovite (e.g., Petersen[22], Butkovich[10] while enhancing the debonding of water absorbed within tuff's clay matrix described by Stephens, et al.[23]

An interesting result of the P*EQ formulation is that for high water concentrations ($n_0^{(2)} > .35$), the water temperatures decrease below that of the PTEQ mixtures and the tuff is hotter. (Note the $M_W = .25$, P*EQ energy partition curve plotted in Fig. 3.16). This result is due to the "extra" thermalization of kinetic energy by the tuff in the P*EQ model. A calculation of the mixture entropies behind the shock for $M_W = .25$ mixtures reveals that the P*EQ assumption requires entropy gains across the shock equivalent to or slightly greater than, the PTEQ case for $u > 1.8 \times 10^5$ cm/sec. Thermal equilibration far behind the shock wave results in further entropy gains. Under these conditions, the shock front will accelerate until it matches the PTEQ shock velocity.

*The phase line in Fig. 3.17 separates liquid water (above) from ICE-VI and VII states. The ICE-VII line is Snay and Rosenbaum's[19] extrapolation of Bridgman's[20] experimental data. A shock-induced phase change in water at 115 kbar, detected by Altshuler, et al.[21] is also indicated in Fig. 3.17. In view of the ICE-VII phase-line extrapolation, this need not have been a liquid-ICE-VII transition. It should also be noted that the experiments performed by Rice and Walsh[13] did not indicate a shock transition in water.

3.4.3 Release States (Strengthless Mixtures)

Dynamic unloading of materials shocked to the high pressures under consideration is usually adiabatic. The reversible adiabatic expansion of a mixture from the shocked state provides a characteristic trace of the states achieved in the unloading process. The release adiabats, under the assumption that the mixture has zero strength, may be calculated by numerically integrating the adiabatic equation,

$$pdV = -dE \tag{3.26}$$

A number of such curves for PTEQ mixtures are given in 3SR-267.

In Fig. 3.18, pressure-volume states of the 100 kbar PTEQ, P*EQ and PEQ release adiabats for strengthless water/tuff mixtures (M_w = 0.05, 0.25) are presented. They are typical of such calculations in that they indicate only minor differences in the adiabats prior to water vaporization. The liquid-vapor regime of water was treated under the assumption that the water vapor and liquid are in both pressure and thermal equilibrium (as described in 3SR-267). P_{crit} (in the figure) is the critical pressure of water.

We should first note that the point at which the water vaporization is initiated differs for the models under consideration. The P*EQ curve intersects the steam dome at the lowest pressure levels. Since the water shock entropy in any P*EQ mixture is less than the PEQ value (see Fig. 3.11), this is a consistent result. The fact that the PTEQ adiabat intersection of the steam dome is above that of the P*EQ adiabat, gives evidence that thermal energy is transferred to the water <u>from</u> the tuff in the isentropic expansion of the PTEQ mixture. Had the water entropy level remained at the PTEQ shock value in a subsequent expansion, the steam dome entry would have occurred at a much lower pressure (at about

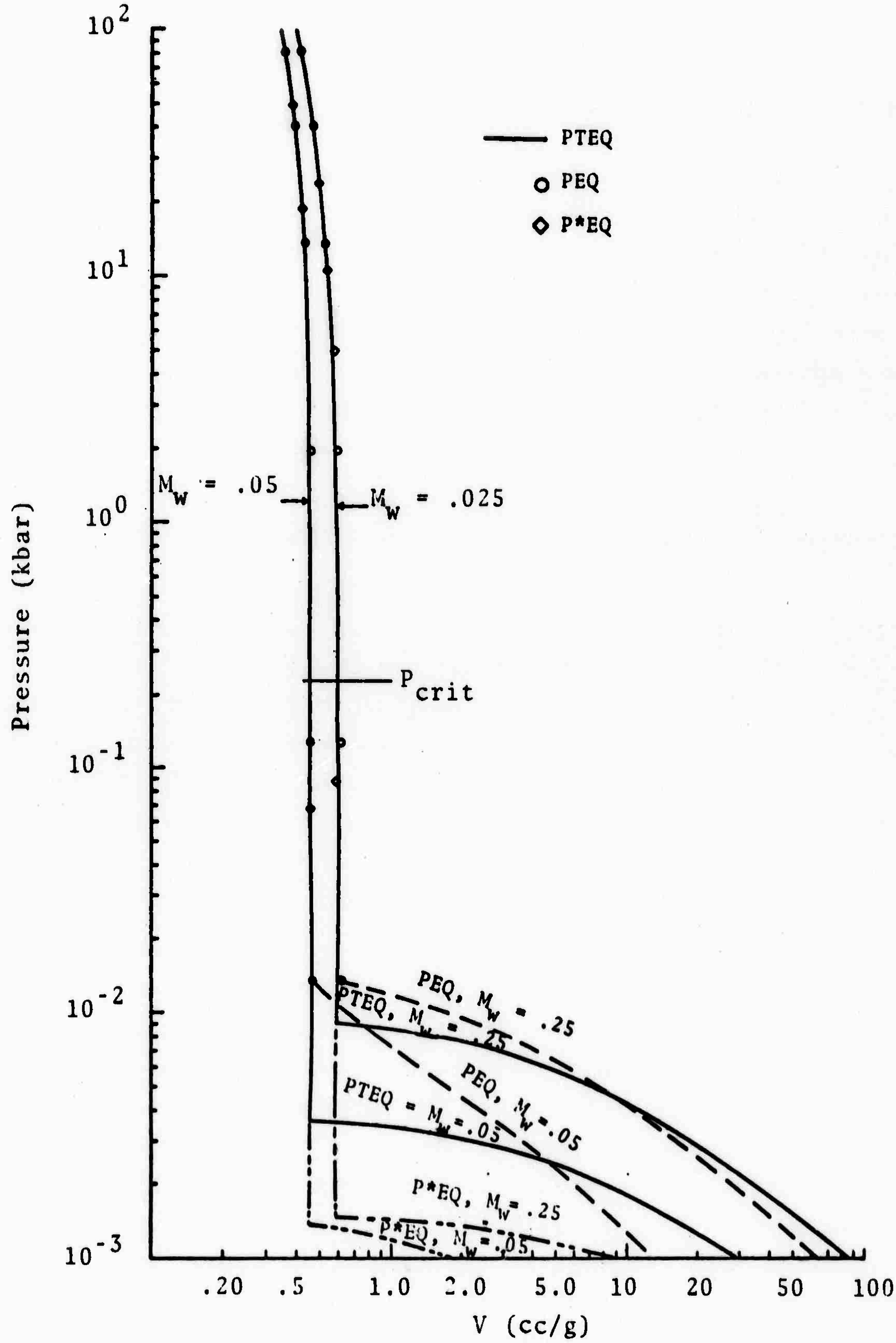

Fig. 3.18--the 100-kbar release adiabats yielded by the three strengthless fluids mixture formulations (M_w = .05, .25).

0.2 bar, off the logarithmic scale in Fig. 3.18).

These results can be generalized inasmuch as the PEQ steam dome entry, for a given shock pressure, is the highest intercept value yielded by the three strengthless fluid mixture models. In contrast, the P*EQ release adiabats indicate water vapor phase transitions at the lowest pressure. For underground explosions, overpressures exist which are of the order of 100 bars. The choice between P*EQ and PEQ can be important, therefore, in the sense that water vaporization might be predicted with the PEQ model for a given release condition, whereas the P*EQ model would release to the overpressure without any steam formation. This is demonstrated in Fig. 3.19 for the isentropic release from a shock pressure of 180 kbar. Any overpressure below 100 bars if the PEQ model were appropriate would be sufficient to allow some water vaporization. The P*EQ transition pressure is a much lower value (32 bars).

The P*EQ model should be closer to physical reality than the PEQ formulation. It is based on the shock interaction processes which could be expected to occur in natural materials.* The PEQ model, on the other hand, has been used (primarily) for the sake of convenience. On this basis, it is recommended that the P*EQ model be utilized in cases wherein thermal equilibration does not occur. The PTEQ model, of course, is most appropriate for relatively long duration pulses** during which thermal equilibrium is achieved.

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*Experimental verification of this conclusion could be achieved if saturated samples were shock loaded to high enough pressures such that vaporization would occur for PEQ but not P*EQ. The sample must be maintained at a suitable overpressure. Water vapor content of the test chamber could be measured to determine the degree of vaporization.

**See Section 2.5 for a description of the pore-size/pulse-duration combinations for which PTEQ is appropriate.

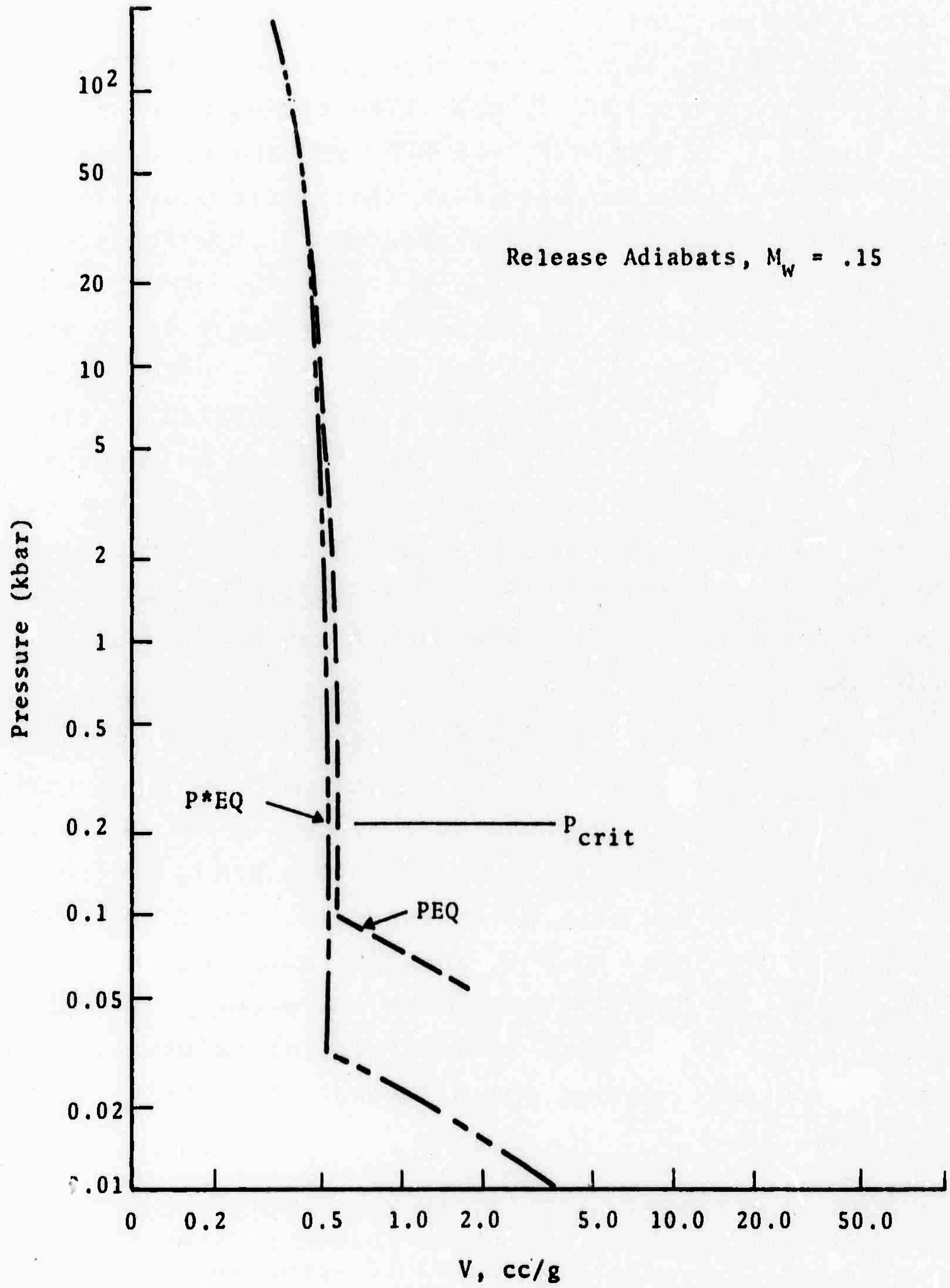

Fig. 3.19--The 180-kbar release adiabats calculated from the two pressure equilibrium strengthless fluids mixture models.

3.5 INITIAL POROSITY EFFECTS - COMPLETE VOID COLLAPSE

Typical geologic media consist of rock or soil matrices containing cracks or pores that may be only partially filled with water. In the previous sections, we have considered the fully saturated condition. When "voids" (e.g., air/water vapor filled pores) do occur, stress waves propagating through the material may crush-out all or some of the unfilled pores. If a large enough pressure is applied (say $p \geq p_c$), the voids will completely disappear and the rock/water matrix may be treated as a fully saturated mixture. This latter situation has been investigated with three mixture models analogous to those described in Sections 3.2 and 3.3.

The major effect of the initial porosity (for $p > p_c$) is to slow down the shock wave (relative to the speed of propagation in the void-free material) and increase the shock heating of the materials. Consequently, the energy partition could be significantly distorted from that obtained with void-free materials.

It should be emphasized that here we do not consider pressure levels wherein incomplete crushing occurs ($0 < p < p_c$). This regime is treated in the next chapter. The (completely crushed) initially porous Hugoniot calculations for tuff/water mixtures presented in this section are physically applicable only above the stress level for which crushing is complete.

3.5.1 Mechanical Aspects of Pore Collapse

Prior to a description of the mixture models utilized in this study, it is appropriate to consider certain mechanical aspects of the pore collapse that are pertinent to the selection of the basic models. More specifically, the problem is to define what possible pore configurations and collapse

mechanisms can be anticipated, and how could they be modeled.

To initiate this we recall that tuff is a fine grain, clay-like matrix mixed with larger size silicate particles (see 3SR-267). The water might tend to be absorbed by the clay matrix so as to completely saturate the smaller pores, thereby leaving all the partial saturation to the bigger pores which are bounded by the loosely connected large particles. Such a model of the partially saturated material would enable treatment of a portion of the water as being in pressure (and perhaps thermal) equilibrium with the solid material. To study the effects of initial porosity in such a mixture, the saturated and unsaturated material could be thought of as "sharing" the voids. The modeling of how these voids are shared determines the internal energy partition for the pressure equilibrium models.*

The rapid collapse of gas-filled pores during a dynamic (shock) process would initiate shock waves propagating into the gas. Under the assumption that the boundary perpendicular to the oncoming shock is (effectively) rigid, it is possible to calculate the degree of compression by the initial shock wave and the reflected shocks. One should also consider the possibility of bubble formation and/or solubility of the gas under the thermodynamic conditions of interest. Using values of the surface tension between water and air (i.e., the order of 50 dyne/cm), a bubble the size of a micron would have to exist for the pressure

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*In any crush process, the energy absorbed by the gas, under compression, is insignificant. Even for a relative temperature increase in the gas ten times that of the wet composite, the mass content is so small (about 0.1 percent of the total mass), that the gas itself can account for only 1.0 percent of the total energy absorbed by the material during the propagation of a crush wave. Thus, the problem reduces to an analysis of how the pressure pulse is transmitted through the partially filled voids.

difference across the bubble surface to be the order of one bar. The significance of bubble formation, it would seem, is that it is the intermediate step prior to the complete solution of the compressed air into the water.

A detailed study of air/water mixtures under high rates of strain at the pressure levels of interest is beyond the scope of the present effort. One may, however, assess the effect that air in the pores of a partially saturated material might have on pressurizing the water in the pore during pore collapse with a simple one-dimensional flow model. The water and solid matrix are treated as incompressible compared to air. The flow problem, illustrated in the distance-time plane in Fig. 3.20, then consists of computing the increase in pressure due to reverberating shocks in air trapped between a rigid wall and a rigid piston advancing toward the wall at a constant velocity, W. The wall and piston are initially separated by a distance x_0, and the air, treated as an ideal gas with $\gamma = 1.4$, are initially at standard conditions and at rest.

Referring to Fig. 3.20, the particle velocity of the air in the odd-numbered states is zero and in the even-numbered states is W, the piston velocity. Starting from an initial state ($p_1 = 10^{-3}$ kbar, $\rho_1 = .00116$ g/cm^3, $u_1 = 0$), it can be shown that the shock velocity, pressure, and density behind subsequent shocks can be computed from the equations.

$$U_i^2 - U_i \frac{(\gamma+1)(u_i + u_{i+1})}{2} - (\gamma-1)u_i - \frac{\gamma p_i}{10\rho_i} = 0 \tag{3.27}$$

$$p_{i+1} = p_i + 10\rho_i (U_i-u_i)(u_{i+1} - u_i) \tag{3.28}$$

$$\rho_i(U_i-u_i) = \rho_{i+1}(U_i - u_{i+1}) \tag{3.29}$$

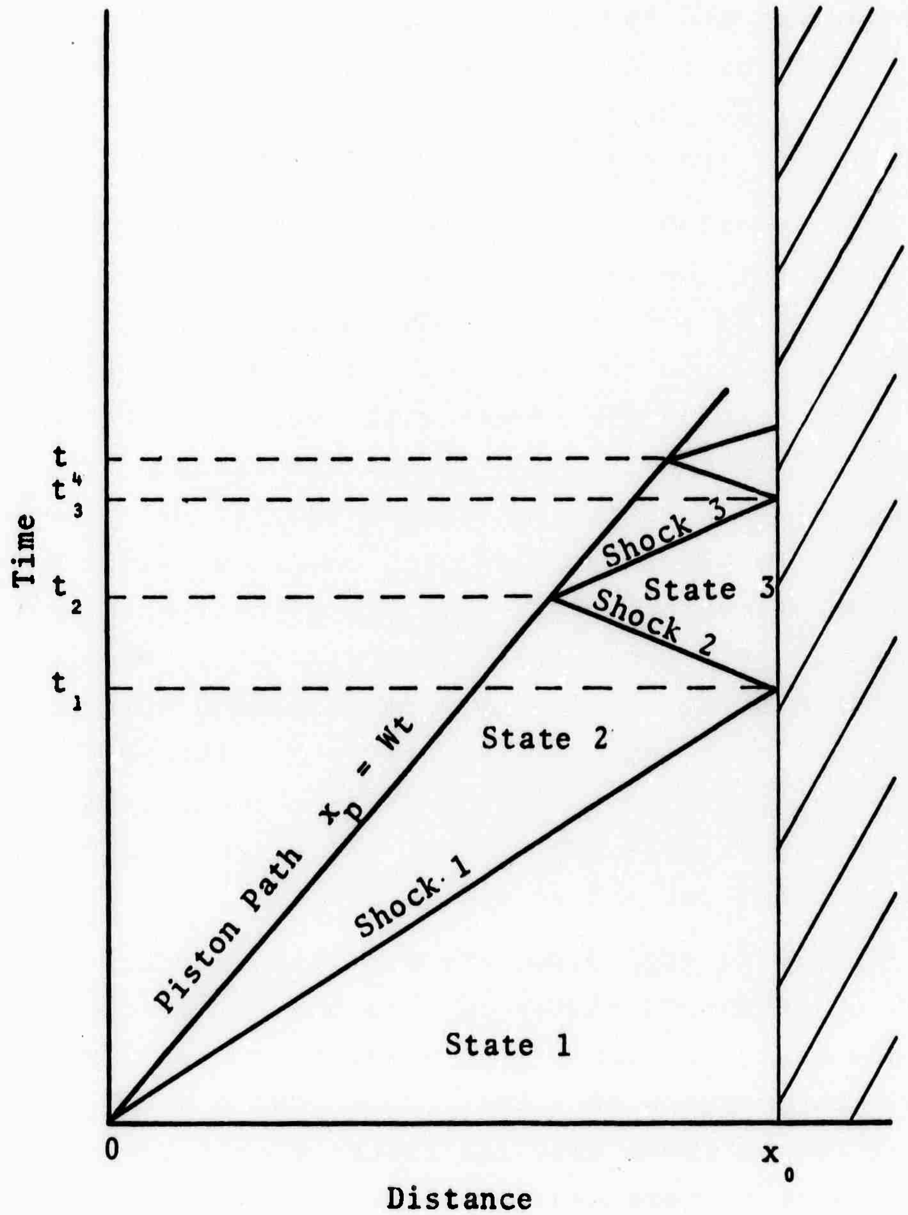

Fig. 3.20--Schematic of the shock wave reflections considered in the pore collapse analysis.

where U_i, u_i, ρ_i, and p_i are the velocity of the ith shock and the particle velocity, density and pressure ahead of that shock respectively. The factor 10 is inserted in Eqs. (3.27) and (3.28) so that they are correct when pressure is in kbars, density in g/cm³ and velocity is in mm/μsec.

As previously mentioned, the assumed boundary conditions are $u_1 = u_3 = u_5 = \ldots = 0$ and $u_2 = u_4 = u_6 \ldots = W$. The piston velocity W was taken to be 0.4 mm/μsec. This value was based on a representative Hugoniot point for tuff in the vicinity of 5 kbar. Solution of Eqs. (3.27), (3.28), and (3.29) for three reverberations yielded the values shown in Table 3.3.

TABLE 3.3

Multiple Shock Compression of Air

i	u_i (mm/μsec)	U_i^* (mm/μsec)	p_i bar	ρ_i g/cm³
1	0	.65	1	.00116
2	.4	.302	4.02	.00298
3	0	.79	12.3	.00694
4	.4		34	

*These shock velocities are relative to laboratory coordinates so the actual speed of shock 2 relative to gas is $U_1 + u_1 = .702$ mm/μsec.

The equations of the shock and piston trajectories were solved simultaneously to obtain the (x,t) points at which reflections occurred. For a pore size $x_0 = 0.1$ mm, it was found that the pore was 92 percent collapsed by the time three shock reverberations had occurred, i.e., by the

time the air was pressurized to 34 bar. The estimated temperature of the air at this time was about 540°C.

On the basis of this simple preliminary calculation, it appears that any significant precompression of pore water due to shocking up of the air in the pores must occur in the very last stages of pore collapse. After 92 percent of the pore collapse, the air (although quite hot) is only up to 34 bars compared to the final pressure of about 5 kbar which will be attained when the solid and liquid are shocked.

Thus, upon complete crush-up, one could anticipate shock reverberations in the crushed material as each pore crushes out. The presence of air could not be expected to significantly dampen the speed at which the boundary is collapsing.* Consequently, the rapid collapse of a pore wall, induced by a primary shock, would result in additional shock wave reverberations as the high velocity wall impacts upon the opposite wall. This is the physical basis of the initially porous modes (P*EQP), analogous to the P*EQ formulation in void free mixtures.

3.5.2 Initial Porosity Models

Three models have been chosen to study the effects of initial porosity on the Hugoniot states of fully crushed (initially porous) water/tuff mixtures. The first of these is the PTEQ model wherein the constituents are in thermal equilibrium behind the shock zone. These states are calculated exactly as those of the initially saturated PTEQ

*It is true, of course, that eventually the air gap would compress enough to match the pressure behind the moving boundary, but by this time, Taylor instabilities at the interfaces due to the density differential would mix the air with the water/tuff composite.

Hugoniots with the exception that the energy jump Eq. (3.7) is now written,

$$\Delta E = \frac{(p + p_0)}{2} \left(\frac{V_0}{1 - n_0^{(3)}} - V \right) \qquad (3.30)$$

where $V_0 / \left(1 - \left(n_0^{(3)}\right)\right)$ is the initial specific volume of the porous mixture.

This equation (3.30) is appropriate for any material, porous or not. However, the simultaneous solution of this equation and the PTEQ equation of state implies that,

1. The voids are completely collapsed behind the shock zone.

2. All of the internal energy rise (i.e., the shock heating) goes into the PTEQ mixture.

As in the case of the fully saturated models, the PTEQ states provide the standard thermodynamic reference for comparison to any mechanical equilibrium formulation. One such model is the PEQP theory. The fundamental PEQP pore hypothesis is that the voids are evenly shared by the tuff and the water. The Hugoniot states are obtained by first determining the various Hugoniots of the pure, porous constituents. These shock states can be readily derived if the equation of state of the compacted materials is known. Poreless $\overline{\text{NTS}}$ tuff and water are described by relations of the form,

$$p_i = P_{H_i}(V_i) + \frac{G_i(V_i)}{V_i} \left(E_i - E_{H_i}(V_i) \right) \qquad (3.31)$$

For porous tuff or water, the change in energy on the (porous) Hugoniot is given by Eq. (3.30). Substitution into the state equation of the individual constituent yields

$$P\left(V_i, \overset{(3)}{n_0}\right) = P_H(V_i)\left\{\frac{2 - \left[\frac{G_i(V_i)}{V_i}(V_0 - V_i)\right]}{2 - \frac{G_i(V_i)}{V_i}\left(\frac{V_0}{1 - \overset{(3)}{n_0}} - V_i\right)}\right\} \tag{3.32}$$

$P(V, \overset{(3)}{n_0})$ is the locus of shock states which is thermodynamically consistent with the tuff or water equations of state and the assumption of complete crushing.*

Then, for the same value of void fraction, $\overset{(3)}{n_0}$, imposing the pressure equilibrium condition between the pure material Hugoniots results in the PEQP Hugoniot curve for that value of $\overset{(3)}{n_0}$. Analogous to the PEQ model for initially saturated mixtures, this type of pressure equilibrium formulation is, of course, arbitrary. Other models could also be considered wherein the pores are all in the tuff, all in the water, etc. Limitation of the PEQP formulation to the equal voids-sharing hypothesis is a compromise model.

The third model is related to the P*EQ theory described in Section 3.3. It has been concluded in the preceding section that the physical process of pore collapse most probably involves shock reverberations analogous to those observed in saturated materials. However, the shock reflection problem is complicated by the multiple shock interactions resulting from the pore collapse. This can be easily seen if the pores are considered as void-gaps separating the bilaminates in Fig. 3.2. A crush wave propagation process would then proceed in a sequence of steps. First, the crushed material impacts on a bilaminate causing a sequence of shock waves to travel through the tuff and water laminates. Due to the shock impedance mismatch,

* The contribution from the initial pressure, p_0, has been neglected in the derivation of Eq. (3.32).

the initial water shock pressure would be less than that of the tuff. Hence the entropy reduction associated with the double-shocking of water is still present in the porous case. However, upon impact with the succeeding bilaminate additional shock waves are formed in the water. These secondary shocks are, at the least, comparable in strength to the initial shock because the impacting bilaminate is moving at a (local) speed close to the free surface velocity of the water/tuff mixture. It can be anticipated that since the local particle velocity will be roughly twice the overall particle velocity and the sound velocity will be comparable to those values in Table 4 of Appendix B; the secondary disturbance in the water is supersonic.

A simple means of taking this into account is to calculate the Hugoniot states of initially porous mixtures and double the P*EQ water entropy level for a given particle velocity. This is the basic postulate of the P*EQP model. Algebraically, the P*EQP shock states are given by:

$$p = P_W\left(V_W, S_{Wp}\right) = P_T\left(V_T, S_T\right) \tag{3.33}$$

$$S_{Wp} = 2\ S_W\left(u, \overset{(2)}{n_0}\right) \tag{3.34}$$

$$\frac{u^2}{2} = \left(\frac{p + p_0}{2}\right)\left(\frac{V_0}{1 - \overset{(3)}{n_0}} - V\right) \tag{3.35}$$

$$V = M_T\ V_T + M_u\ V_W \tag{3.36}$$

It should be stressed that this formulation is not intended to be construed as <u>the</u> solution to the porous composite problem. The model is a useful approximation of the shock reverberation effects encountered in the shock crushing

of void materials.* As such, it should offer a markedly different set of Hugoniot states to be compared with the other two models and the available experimental data.

Qualitative verification of the P*EQP model was obtained in a SKIPPER calculation (run 795) wherein void-gaps were introduced between the bilaminates (see Appendix C for details). An applied boundary velocity of 7.786×10^4 cm/sec was applied to the wet tuff and block. Laminate dimensions and sequential placement for this run were 0.0703 cm, 0.01485 cm, and 0.01485 cm for the tuff, water, and void-gap, respectively (from left to right).

The P*EQP states are in agreement with the run 795 results. As in the case of the saturated bilaminate runs, the water entropy signature stabilizes shortly after the major wave interactions occur. Figure 3.21 is a comparison of the entropy signature to the S_{Wp} from Eq. (3.34). The mean entropy in the water is eight percent higher than the predicted value. Interestingly, the P*EQP pressure is from 1 to 3 kbar higher than the indicated equilibrium pressures of the laminates (see Fig. 3.22). In view of the agreement in water entropy values, this small discrepancy must be associated with the quasi-steady nature of the propagating disturbance.**

*Strictly speaking, S_{Wp} is a function of u, $\overset{(2)}{n}_0$, and $\overset{(3)}{n}_0$. Consequently, the limit of S_{Wp} as $\overset{(1)}{n}_0 \to 0$ should be that given by the initially porous states of equal initial void fractions. From 0 to 200 kbar, the P*EQ limit (i.e., $2\ S_W(u, \overset{(2)}{n}_0)$ is within 20 percent of the pure water values for initial porosities less than 0.20.

**A ten percent difference in equilibrium entropy results in less than 0.5 percent difference in the pressure.

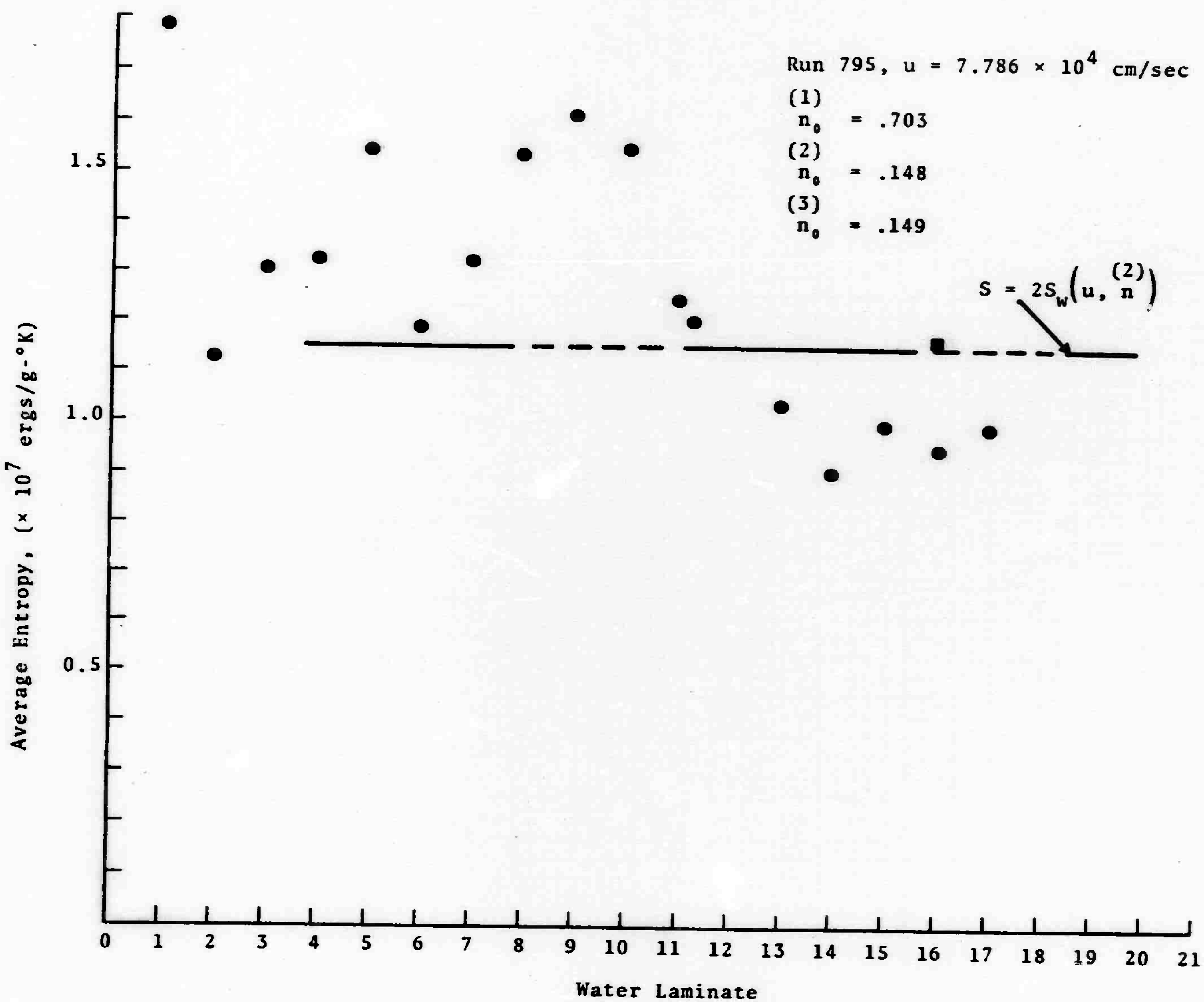

Fig. 3.21--Water entropy signature observed in SKIPPER Run 795 (structure contained void gaps).

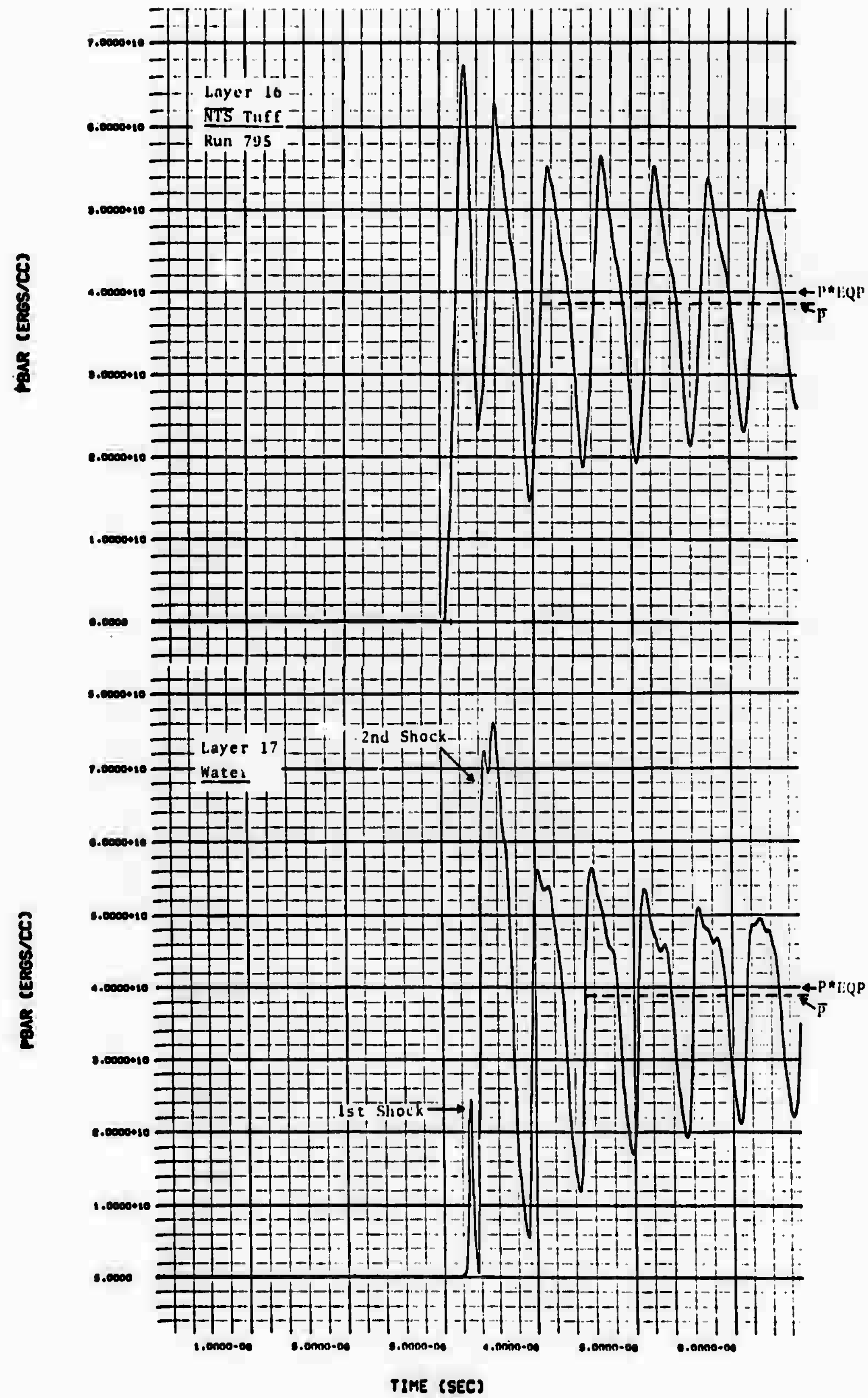

Fig. 3.22--Pressure versus time in tuff and water laminates calculated in Run 795.

That is, the total shock interaction zone is still growing with time, and the stress level will eventually achieve the P*EQP value under steady flow conditions.

Finally, it should be remarked that the numerical results indicate that the major entropy gain in the water (about 80 percent) occurs after the water impacts on the adjacent tuff laminate. The sequence of events is depicted in the water entropy and particle velocity traces in Fig. 3.23.

It is evident that the wave interactions are complex, and that this second shock is formed when the double pressure is sandwiched between the two tuff laminates. Following this initial sequence, some minor shocklets result from succeeding impacts.

3.5.3 Initial Porosity Calculations

Shock Results - Mechanical

The overall effect of increasing initial porosity is to reduce the shock propagation speed for a given particle velocity from that which results in initially saturated mixtures. The spread in the measureable Hugoniot states is also reduced at the higher porosities. Shock velocity-particle velocity curves for void fractions of 0, .1, and .2 are presented in Fig. 3.24. The PTEQ states are the dotted lines. Porous tuff and water curves are also drawn. The close agreement between the three models makes it convenient to plot the PEQP and P*EQP results as individual points.

A very limited amount of experimental data are available for partially saturated tuffs. The laboratory results of Lysne and Bass[18] and Weidermann and Kurth[17] are included in Fig. 3.24. As in the case of the saturated results, NTS tuff

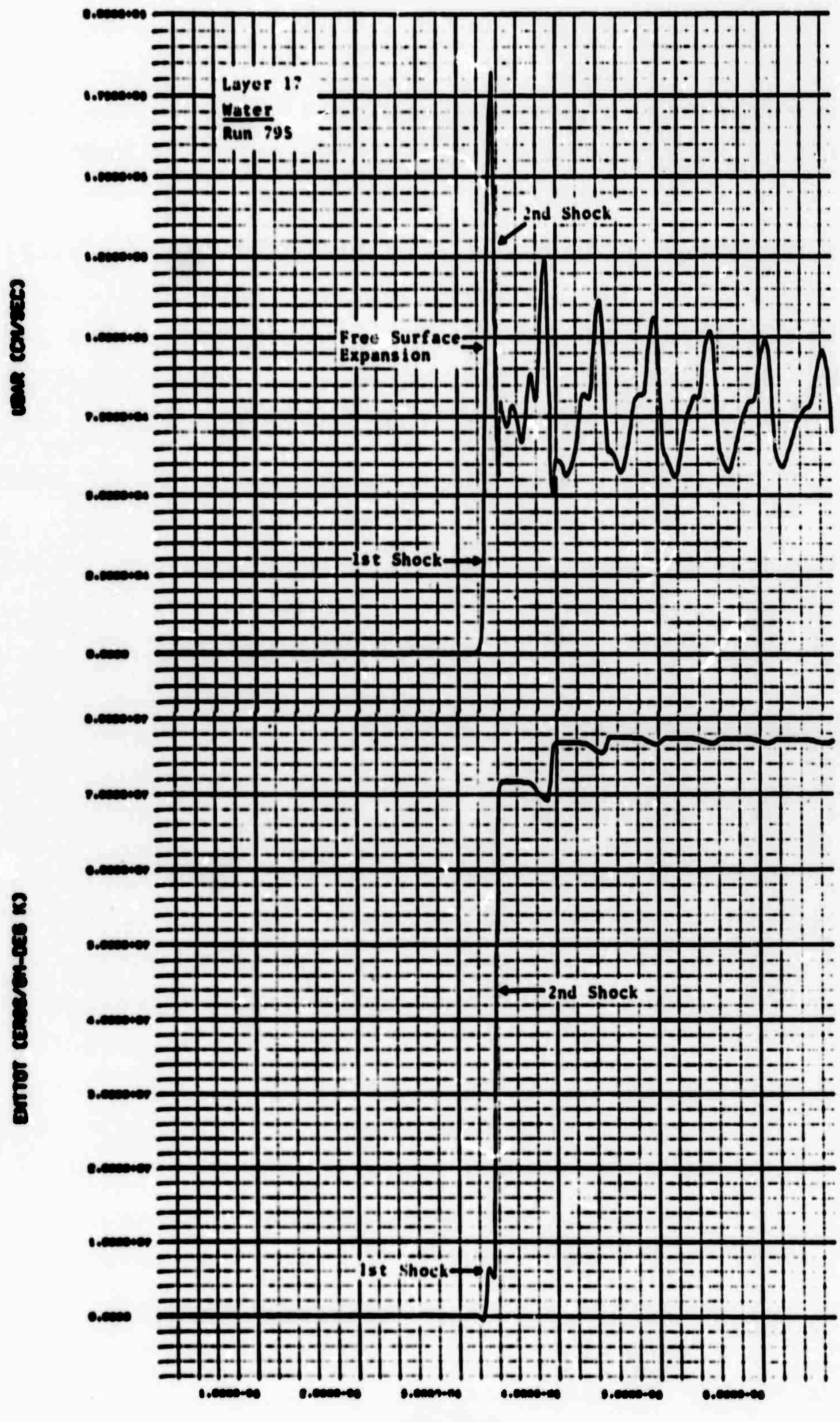

Fig. 3.23--Typical response of the water laminates to the crush wave calculated in Run 795.

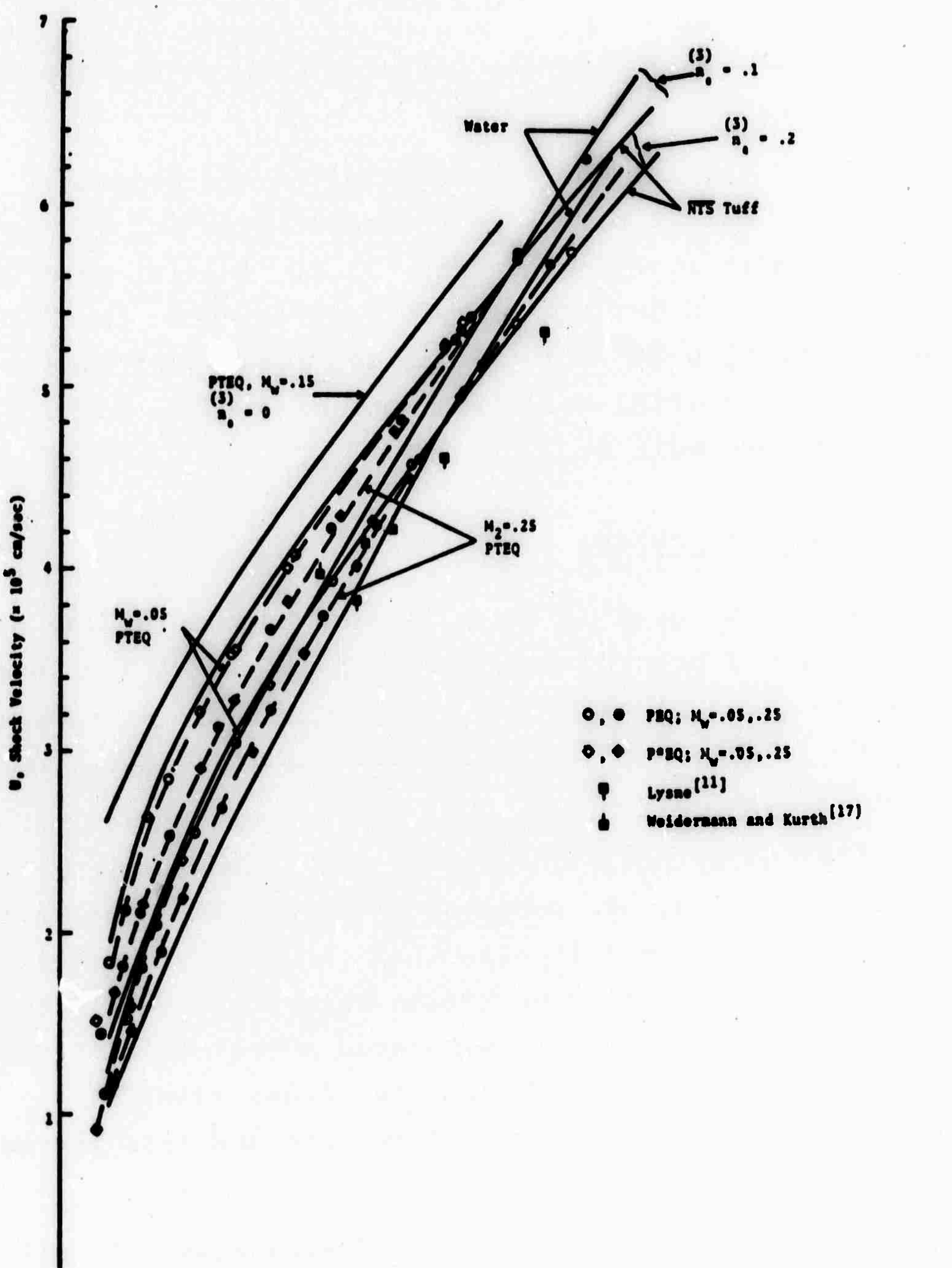

Fig. 3.24--Shock velocity, U, as a function of particle velocity, u, for partially saturated $\overline{\text{NTS}}$ tuff/water mixtures that are completely crushed by the shock wave. Experimental results are compared above a shock pressure of 30 kbar.

yields a reasonably accurate correlation with the experimental values.

The "shifting" of the Hugoniot in the pressure-volume plane due to porosity is demonstrated for 0.05 and 0.25 water mass fractions in Fig. 3.25. Initial porosity was 20 pe ent in both cases. For convenience, the PTEQ Hugoniots of 0, 0.05, 0.15, 0.25, and 1.00 water mass fractions and initial void fractions of 0, 0.1, and 0.2 are included in Appendix B.

Shock Results - Thermal

As in the case of the saturated Hugoniots, the principal differences between models are exhibited in the internal energy partition of the Hugoniot states. This is especially important in determining the release states of the compacted mixtures.

The energy partition curves for values of $n_0^{(3)} = 0.1$, 0.2 and $M_W = 0.15$, are compared in Fig. 3.26. Within this range of values, the main effect of the initial porosity is to squeeze the energy partition curves together (in comparison to the initially saturated Hugoniots). Although at low shock pressures, larger void volume fractions in the P*EQP model would tend to result in less and less thermal energy absorption by the water.

The extra shock heating associated with the initial porosity results in higher temperatures of the constituents than in an initially void-free composite. Shock temperatures for the three models are plotted in Fig. 3.27 for $n_0^{(3)} = 0.2$

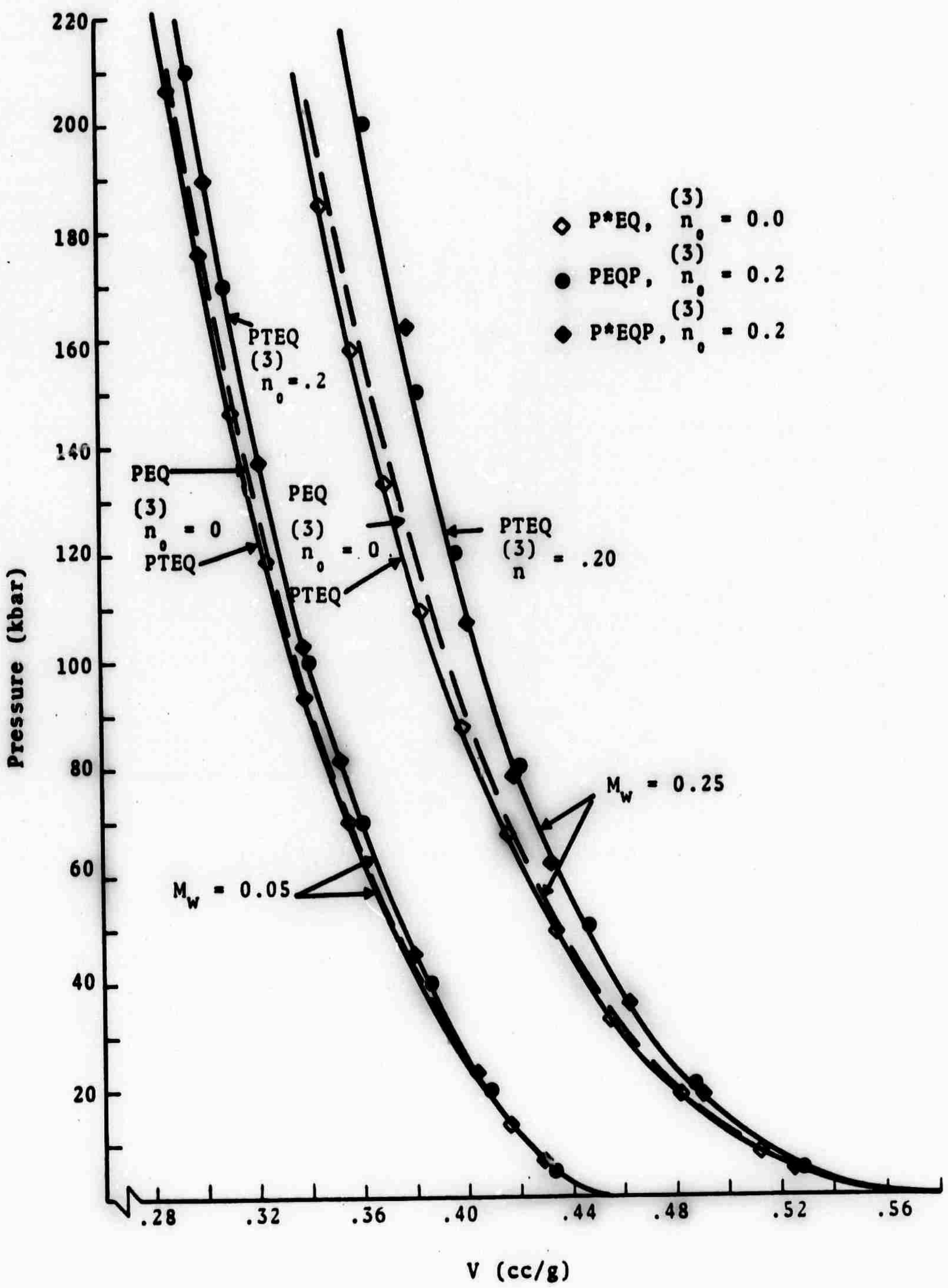

Fig. 3.25--"Shifting" of the Hugoniots in the p-V plane due to the extra shock heating associated with initial porosity of NTS tuff/water mixtures.

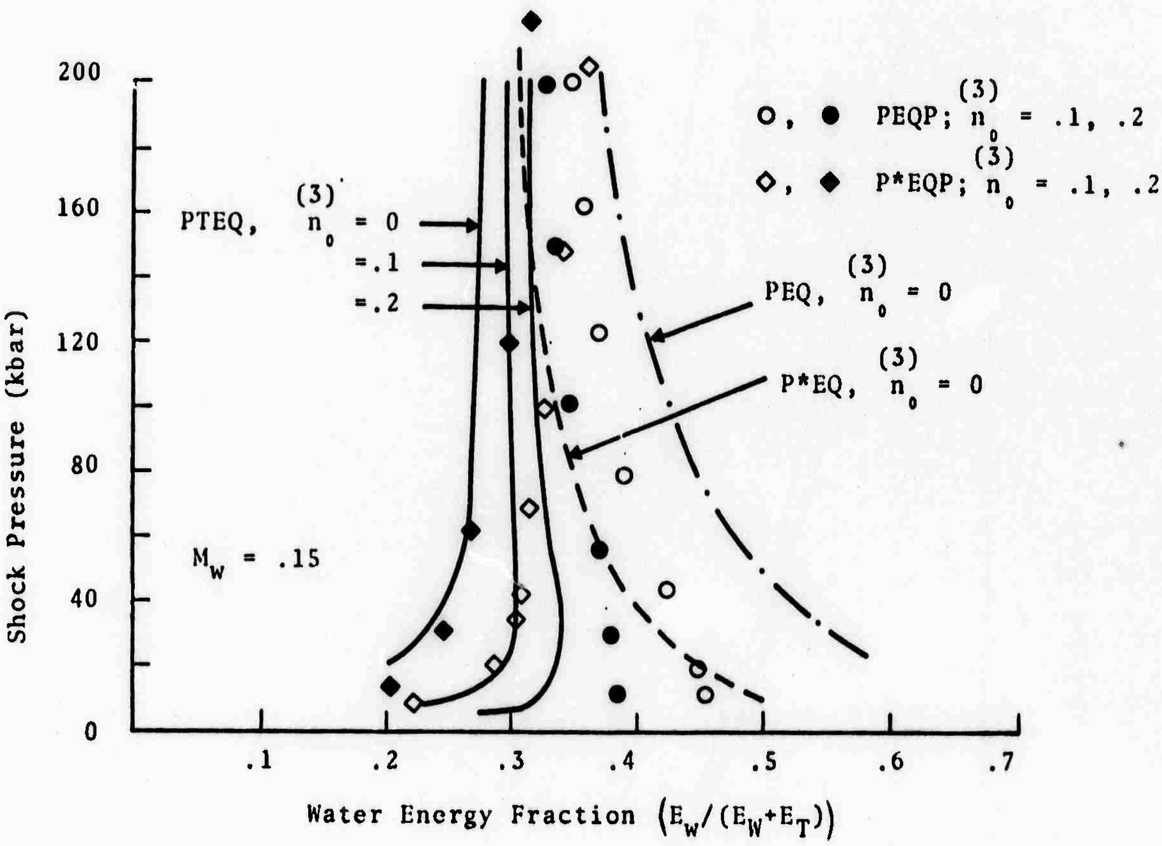

Fig. 3.26--Energy partition as a function of shock pressure for the three initially porous models. (M_W = .15 and complete shock crushing is assumed.)

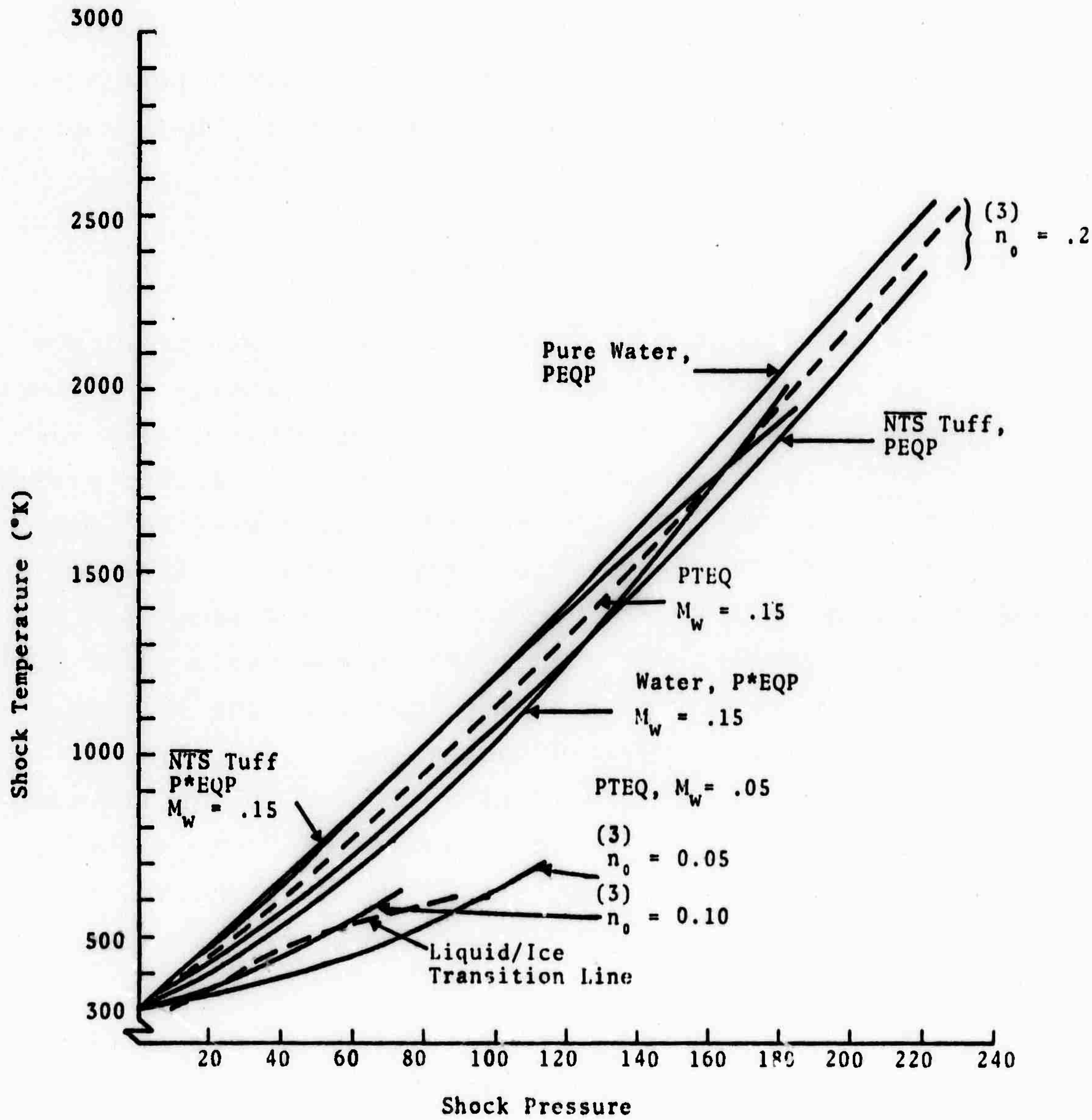

Fig. 3.27--Shock temperatures in completely crushed NTS tuff/water mixtures which were initially porous.

and a 0.15 water mass fraction. At this value of porosity, the material temperatures are fairly close to one another. The maximum spread is about 170°K for the P*EQP formulation at a mean temperature of 1000°K. It can be seen that the chances of a liquid/ice phase transition are lessened due to the shock heating effect. Even at 5 percent porosity, only the PTEQ model yields water temperatures that fall under the phase transition line (see Fig. 3.27).

Release States (Strengthless Fluids)

Release isentropes from the Hugoniot states of the initially porous models are calculated in exactly the same manner as the initially saturated strengthless fluids mixture release curves (Section 3.4). Since all models presume total pore collapse, the shocked material obeys the same equations of state as the PTEQ and pressure equilibrium models during an adiabatic expansion. The entropy and temperature, of course, are higher due to the extra shock heating associated with the initial porosity of the mixture. Figure 3.28 compares the 100 kbar release curves for a 0.15 water mass fraction PTEQ mixture with void volume fractions of 0, 0.07, and 0.23. The shock heating effect on the release curves is to boost the steam dome entry point of the release curve in the $n_0^{(3)} = .07$ case and effectively shock vaporize the water for $n_0^{(3)} = .23$.

The three strengthless fluids mixture models yield significantly different steam dome entries for low shock pressures. (This could be anticipated from the energy partition curves in Fig. 3.26.) Release adiabats from the 50 kbar shock pressure for a 0.15 water mass fraction and values of $n_0^{(3)} = 0.1, 0.2$ are plotted in Fig. 3.29. The relatively low shock entropy values in the P*EQP model delays the water vapor phase transition to lower pressures. This may be an important effect in pulse propagation through

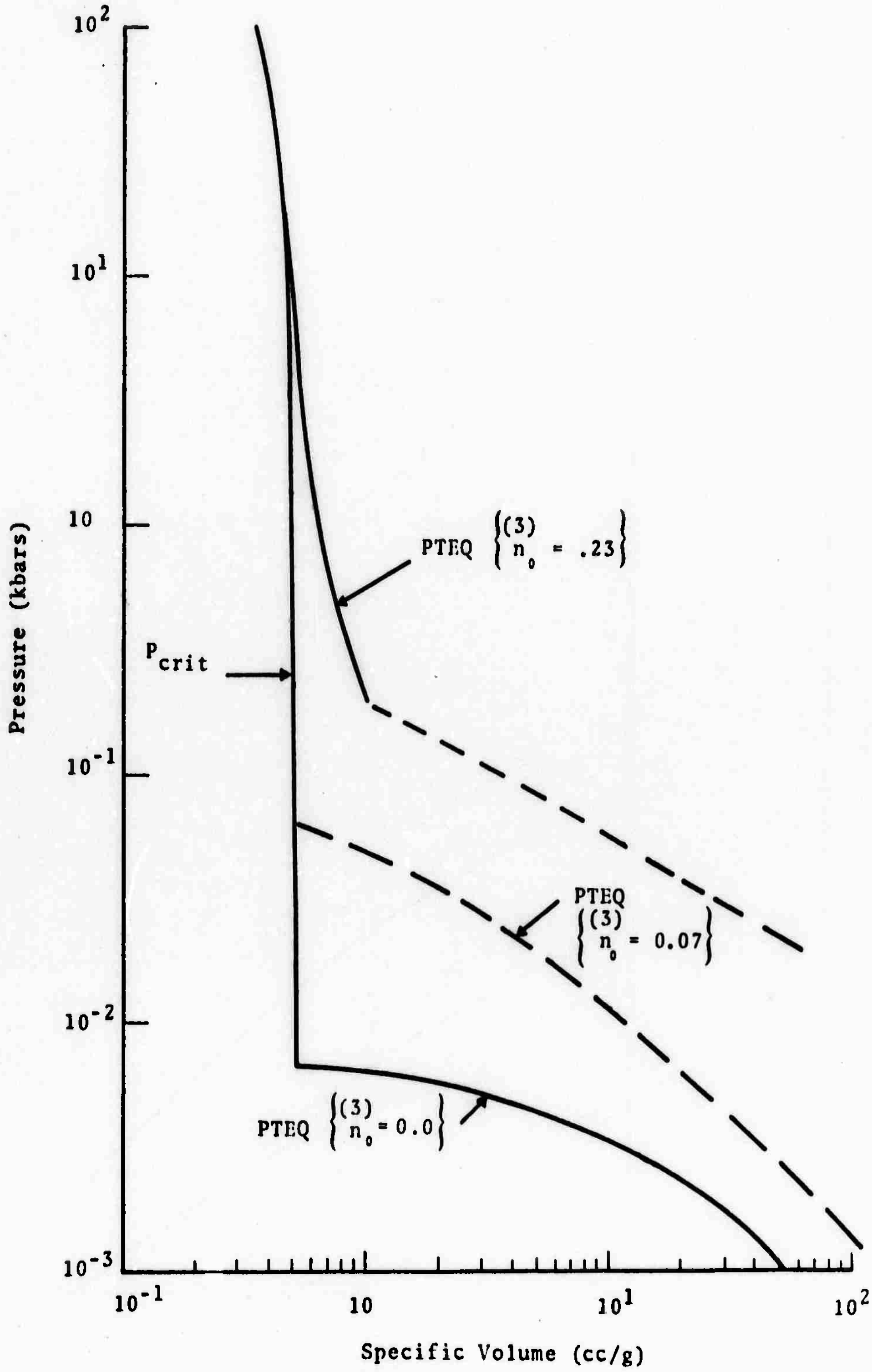

Fig. 3.28--Effect of initial porosity on the shape of the release adiabat of PTEQ mixtures.

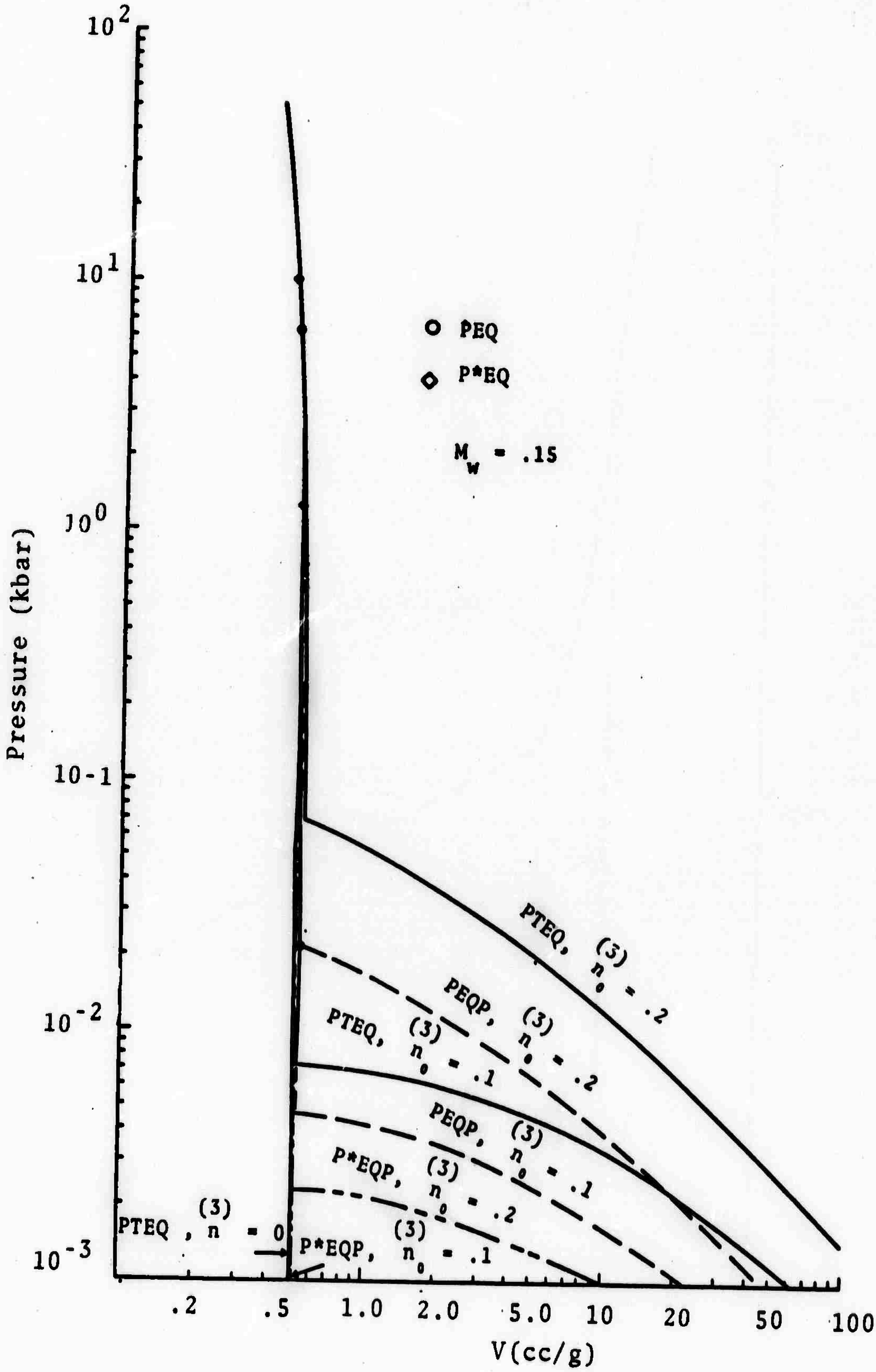

Fig. 3.29--A comparison of the 50-kbar release adiabats predicted by the three initially porous models for two values of $n_0^{(3)}$.

partially saturated porous tuff. A more definitive treatment of the problem is required to further analyze these effects. The basic P*EQP model could be refined by determining $S_{Wp}(u, n_0^{(2)}, n_0^{(3)})$ from the results of a series of void-gap SKIPPER runs.

IV. CRUSHUP MODELS

4.1 INTRODUCTION

In the last chapter we have presented thermodynamic equations of state for porous tuffs shocked to pressures above the value for which total collapse of the voids is assured. Attention was focussed on the partition of the energy between the water and tuff matrix constituents in order to adequately treat the possible phase change in the water upon shock release. In this chapter, attention will be centered on the lower pressure regime where it is necessary to consider the irreversible mechanical crushup of the tuff matrix. The analysis is based primarily on isothermal hydrostatic test data which indicate that for a given tuff there is a pressure, p_c, and associated density, ρ_c, corresponding to the hydrostatic loading at which complete void collapse first occurs.

A phenomenological model for the crushup regime has been presented by Herrmann[24] within the framework of a single continuum. His model utilizes uniaxial strain data to construct a p-α model that coalesces the low pressure crushup treatment with the high pressure model by the use of the equation of state for the poreless material to compute reference states. This concept of using the equation of state of the poreless medium to provide reference states will be generalized here in constructing models for the crushup of a porous composite material within the TINC framework. The approach is general enough to permit the PEQ, PTEQ or the P*EQ equation of state to be used for calculating the reference states for the poreless composite material.

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In Section 4.2 a conceptually simple void collapse model is presented for a porous dry rock under hydrostatic isothermal loading. The model hinges on the use of a volume scaling function $\left(\eta^{(1)} = \eta\right.$, the volume fraction occupied by the poreless matrix material$\left.\right)$ to introduce the effective density and effective pressure of the poreless rock matrix. Then the postulate is made, analogous to the TINC treatment of the binary composites in Chapter II, that the effective density and effective pressure are related just as they are for the poreless rock; the effects of porosity and crushing are contained in the scaling function η. The model is applied to a number of specific tuffs for which adequate isothermal crushup data area available under the additional assumption that there is no void reopening upon unloading. From these studies a general model for a representative tuff matrix, NTS porous dry tuff, is constructed that makes it possible to predict the isothermal crushup of porous dry tuffs with different initial porosities and poreless ("crystal") densities.

The introduction of water into the pores does not alter the basic crushup model in that the porosity and crushing are still described through the volume fraction scaling functions and the void collapse is still considered irreversible. In the *in situ* rock, there exists a distribution of the pore sizes. Some of these may be fully saturated, others partially saturated and still others completely dry. The theoretical considerations are simplified by postulating either that the pores are connected such that the water is not pressurized until all of the voids are removed, or that the pores are disconnected such that the water is in pressure equilibrium with the porous (void filled) rock.

In Section 4.3 models for the isothermal crushup of partially saturated wet porous rock are developed for both the connected and disconnected pore postulates. The disconnected pore model is applied for a limited number of similar tuffs for which isothermal crushup data are available. Prediction based on the disconnected pore model, compressive behavior of water, and the corresponding porous dry tuff model are found to overestimate the resistance to crushup of the wet tuff. This is explained in terms of the weakening of the tuff matrix by the presence of the water. Better agreement may be obtained by reducing the crushup pressure below the dry matrix value to one appropriate to the wet matrix.

The thermodynamic effects are introduced in Section 4.4 through the equations of state of the poreless matrix rock which relate the effective pressure and temperature to the independent variables, i.e., density and specific internal energy. In the case of the porous dry tuff, all of the internal energy goes into the solid. When water is introduced, the internal energy is partitioned between the solid and liquid as discussed in Section 3.2. The theory (presented in outline form for porous dry tuff) is simplified by assuming that the volume scaling function is not affected by the internal energy variations; rather it remains unchanged from the function determined from isothermal crushup data.

The crushup models are being developed such that they can be incorporated into both a classical continuum mechanics code (such as SKIPPER) and a TINC code (such as POROUS). Whereas the models can be implemented directly into a TINC code, a table lookup scheme can be used as an efficient means of including the crushup models in a classical continuum mechanics code.

4.2 POROUS DRY TUFF ISOTHERMAL CRUSHUP MODEL

The pressure $p\left(=\overset{(1)}{p}\right)$, in the poreless solid is given by the mechanical equation of state,

$$p = P_1\left(\overset{(1)}{\rho}e/\overset{(1)}{\rho_0}e\right) = P_1\left(\overset{(1)}{J}e\right) \tag{4.1a}$$

where

$$P_1(1) = 0 \tag{4.1b}$$

We now consider a solid with pores. If $n\left(=\overset{(1)}{n}\right)$ denotes the volume fraction of the poreless solid matrix material, then the partial pressure exerted by the poreless solid in the composite is:*

$$\overset{(1)}{p} = n\,P_1\left(\frac{n_0}{n}\,\frac{\overset{(1)}{\rho}}{\overset{(1)}{\rho_0}}\right) = n\,P_1\left(\frac{n_0}{n\overset{(1)}{J}}\right) \tag{4.2}$$

For a dry porous solid $\overset{(1)}{p}$ and $\overset{(1)}{\rho}$ equal the bulk pressure (p) and the bulk density (ρ), respectively. It is convenient to introduce the postulate that n is a function of ρ/ρ_0 $\left(=\overset{(1)}{\rho}/\overset{(1)}{\rho_0}\right)$, i.e.,

$$n = n\left(\rho/\rho_0\right) \tag{4.3a}$$

with

$$n(1) = n_0, \tag{4.3b}$$

and

$$n\left(\rho_C/\rho_0\right) = 1 , \tag{4.3c}$$

*The constitutive scaling relation on which Eq. (4.2) is based is derived in Section 5.2. It was also presented in 3SR-267.

where ρ_C denotes the crushup density. In the present formulation, the void collapse is assumed to be irreversible, i.e.,

$$n'(\rho/\rho_0) \geq 0 \qquad \rho/\rho_0 \text{ increasing}$$
$$= 0 \qquad \rho/\rho_0 \text{ decreasing} \tag{4.4}$$

where the prime indicates differentiation with respect to the argument ρ/ρ_0. We remark here that the assumption (4.4) is not central to the present discussion and may be relaxed to better fit experimental data when required.

To illustrate the application of the above ideas, let us consider the crushup curve OCA shown in Fig. 4.1. ACB is the reversible path after complete crushup. ρ_B represents the density of the poreless matrix material at zero pressure. We denote by p^* the pressure along the reversible loading path ACB.

$$p^*(\rho/\rho_0) = P_1\left(n_0 \overset{(1)}{\rho} / \overset{(1)}{\rho_0}\right)$$

$$= P_1(n_0\rho/\rho_0), \qquad \rho \geq \rho_B \tag{4.5}$$

On noting that

$$p_B^* = P_1(1) = 0,$$

we obtain

$$n_0 \, \rho_B/\rho_0 = 1 \tag{4.6a}$$

Rewriting (4.6a), the value of initial volume fraction of the poreless solid is given by

$$n_0 = \rho_0/\rho_B \tag{4.6b}$$

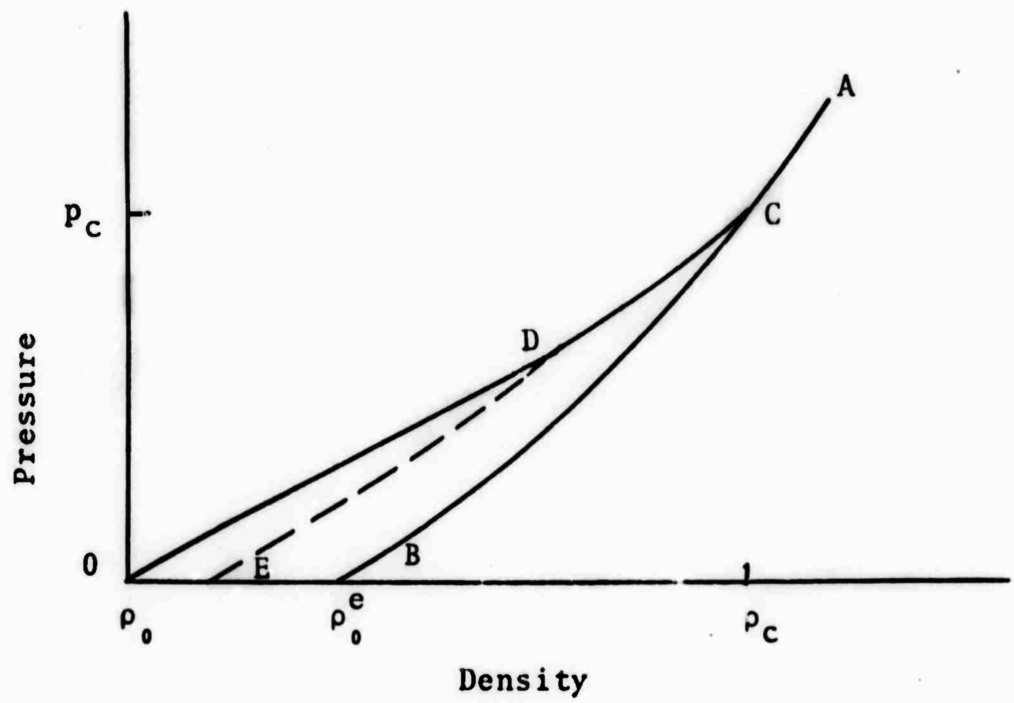

Fig. 4.1--Pressure-density relations for initially porous dry geologic material

We denote by $\hat{p}(\rho/\rho_0)$, $\rho \geq \rho_0$, the irreversible compaction along OA.

$$\hat{p}(\rho/\rho_0) = nP_1\left(\frac{n_0\rho}{n\rho_0}\right) \tag{4.7}$$

Combining Eqs. (4.5) and (4.7), there follows

$$\hat{p}(\rho/\rho_0) = n\ p^*\left(\frac{\rho}{\rho_0 n}\right) \tag{4.8}$$

Equation (4.8) is an implicit relation for $n(\rho/\rho_0)$ when $n \geq n_0$ and $\rho \geq \rho_0$. The above description is completed by specifying that unloading-reloading along a path DE (see Fig. 4.1) is reversible with $n \equiv n_D$. The present model exhibits both reversible and irreversible behavior in $p(\rho/\rho_0)$ with the void collapse regarded as totally irreversible, Eq. (4.4).

The model, as formulated above, does not incorporate the effect of shear stress on void collapse. In principle, shear effects can be included by postulating that n be a function of some invariant measure of shear deformation in addition to ρ/ρ_0 . To construct such relations would, however, require data from an extensive experimental program on porous materials under pure shear and biaxial loading.

4.2.1 Stoddard Porous Dry Tuff

The proposed model requires that there be experimental pressure-volume data for a dry, porous tuff. Sufficient data points are required to describe the loading of the porous tuff and the unloading of the partially and completely crushed material. The pressure-volume data for Stoddard tuff presented by Stephens[23] are graphically depicted in Fig. 4.2. This material is completely dry and has an initial void content of about 34 percent by volume $\left(n_0 = .66\right)$.

It is assumed that the unloading data from 40 kilobars represent poreless Stoddard tuff. A least squares program was used to fit the data to the form

$$p = \overset{(1)}{P}_1\left(\overset{(1)}{\rho}{}^e / \overset{(1)}{\rho}{}_0^e\right) = a_1 + a_2\left(\overset{(1)}{\rho}{}^e / \overset{(1)}{\rho}{}_0^e\right) + a_3\left(\overset{(1)}{\rho}{}^e / \overset{(1)}{\rho}{}_0^e\right)^2 + a_4\left(\overset{(1)}{\rho}{}^e / \overset{(1)}{\rho}{}_0^e\right)^3 , \tag{4.9}$$

where

$$a_1 = 450.993 \text{ kbar}$$
$$a_2 = 405.696 \text{ kbar}$$
$$a_3 = -2186.603 \text{ kbar}$$
$$a_4 = 1329.914 \text{ kbar}$$

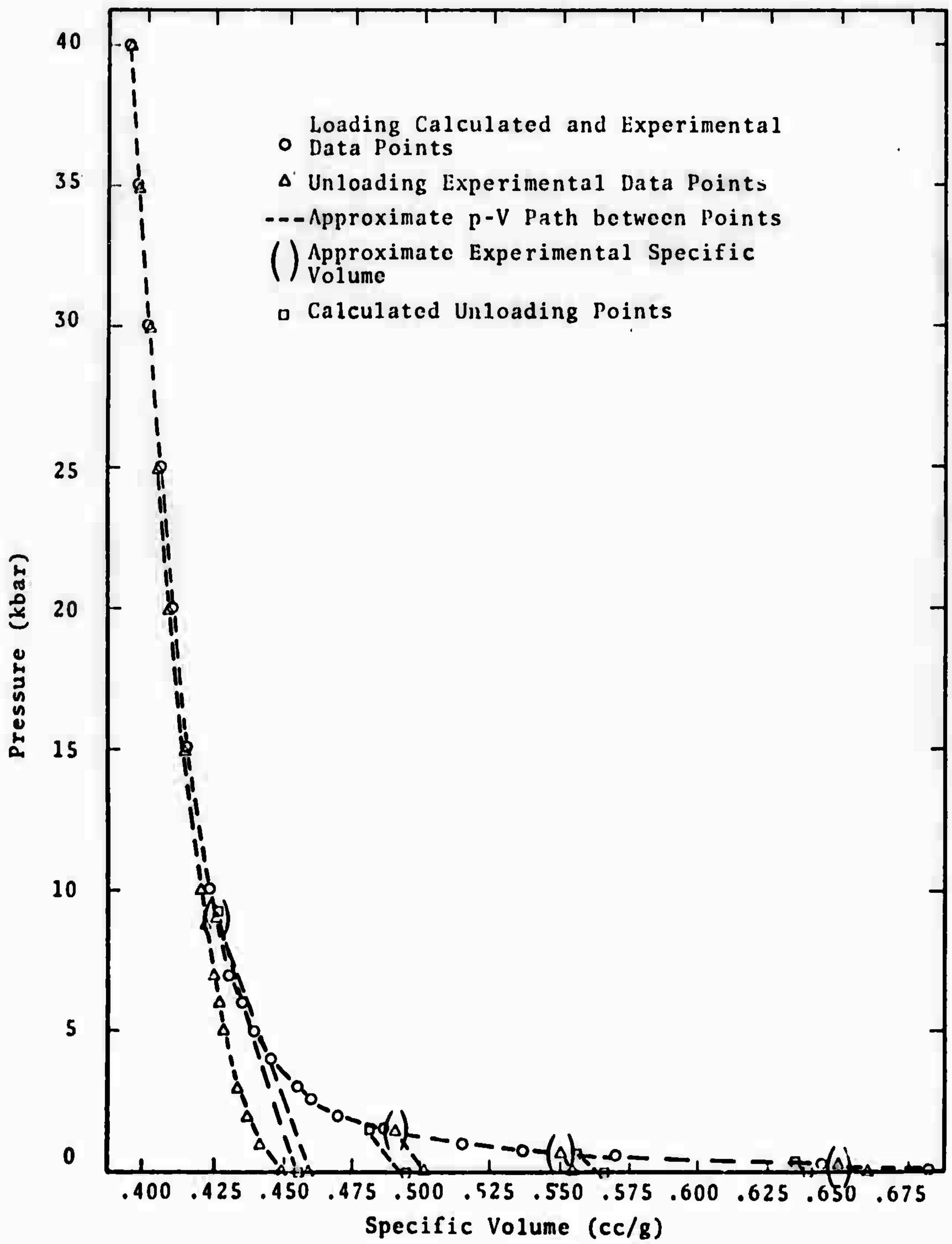

Fig. 4.2--Comparison of experimental and calculated pressure-volume states for Stoddard tuff.

The loading pressure-volume data for porous Stoddard tuff and the poreless Stoddard tuff fit, Eq. (4.9), were used in an iteration program to obtain a series of n vs ρ/ρ_0 $\left(= \overset{(1)}{\rho} / \overset{(1)}{\rho_0}\right)$ points satisfying Eq. (4.8). A least squares program was then used to fit these points to the form

$$n\left(\overset{(1)}{\rho} / \overset{(1)}{\rho_0}\right) = n\left(\rho/\rho_0\right) = a_1 + a_2\left(\rho/\rho_0\right) + a_3\left(\rho/\rho_0\right)^2 + a_4\left(\rho/\rho_0\right)^3 + a_5\left(\rho/\rho_0\right)^4 \tag{4.10}$$

where

$$a_1 = -1.03956$$
$$a_2 = 4.95584$$
$$a_3 = -6.30467$$
$$a_4 = 3.95524$$
$$a_5 = -0.90951$$

This function is shown in Fig. 4.3.

The fits to Stoddard tuff (Eqs. 4.9 and 4.10) were used with the irreversible crushup hypothesis to compute a series of loading and unloading pressure-volume points. These points, along with the experimental data, are illustrated in Fig. 4.2. The calculated loading curve and the unloading curve from 40 kbars, as expected, fall on top of the corresponding experimental data. The calculated unloading curves from 9.0, 1.4, 0.66 and 0.23 kbar are seen to be in good agreement with the experimental data.

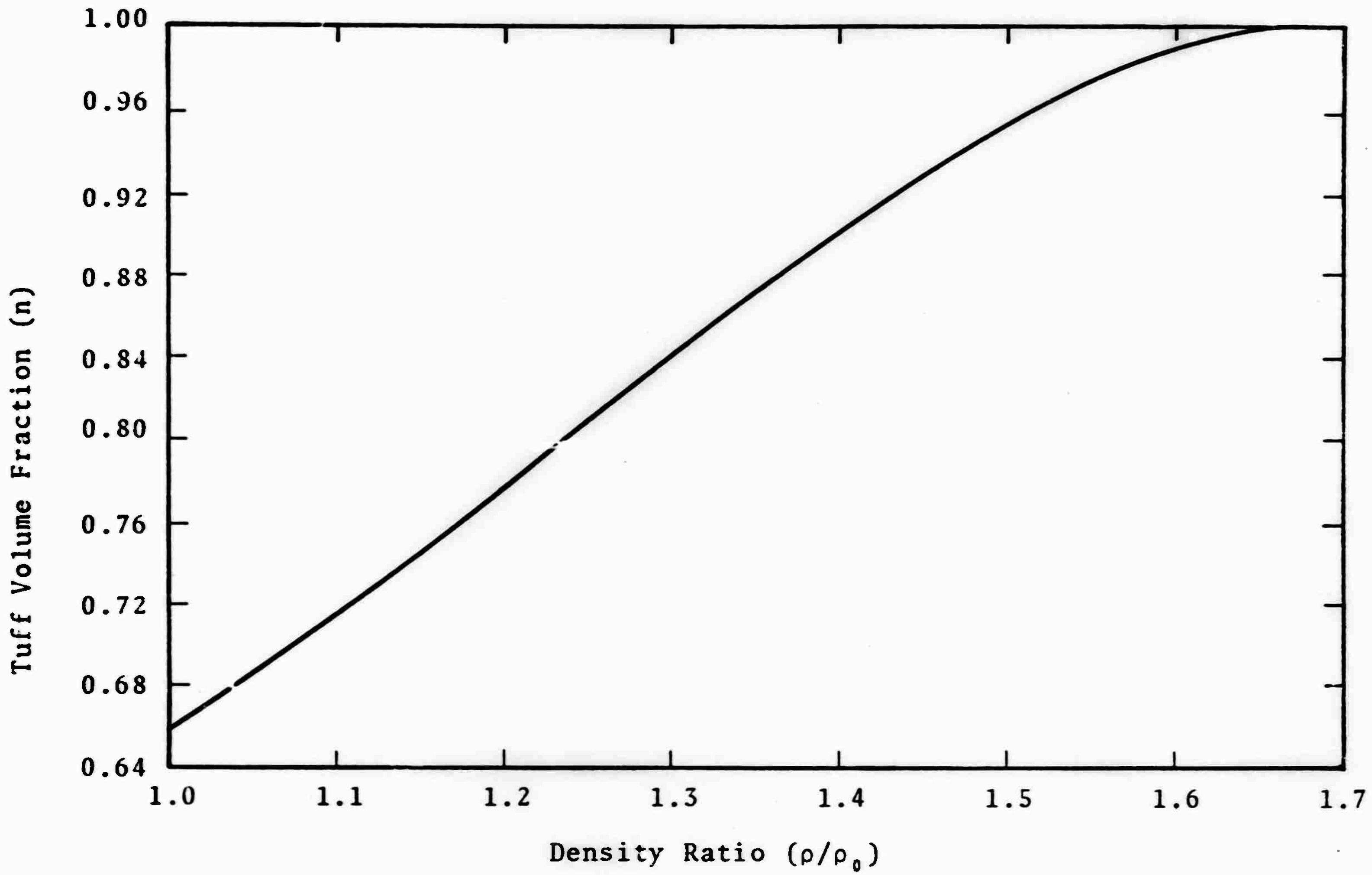

Fig. 4.3--Stoddard tuff: volume fraction <u>vs</u> density curve.

4.2.2 $\overline{\text{NTS}}$ Porous Dry Tuff

Adequate data for a specific tuff with a given initial density from which to obtain the functional relationships $P\left(\rho^{(1)e}/\rho_0^{(1)e}\right)$ and $n = n\left(\rho/\rho_0\right)$ are seldom available. It is, therefore, desirable to develop a description of a representative porous tuff (hereafter referred to as $\overline{\text{NTS}}$ porous dry tuff) with $\overline{\text{NTS}}$ poreless tuff (called S^3 tuff in 3SR-267; for equation-of-state parameters, see Table 2.1) as the matrix material. It is realized of course that such a general representation will be relatively inaccurate for a specific tuff, but it will be useful for model studies as a representative porous material.

With the intent of representing dry tuffs of different crystal densities and/or different initial distensions, we introduce the following normalized variables

$$\alpha \equiv \frac{\rho - \rho_0}{\rho_C - \rho_0}, \qquad \beta \equiv \frac{n - n_0}{1 - n_0} \tag{4.11}$$

It is now assumed that for all curves of $n = n\left(\rho_0/\rho\right)$ (which in general are different due to crystal density and n_0) the relation $\beta = \beta(\alpha)$ will be the same. If the above assumption is reasonable we are able to generate the n-ρ relationship for any dry tuff knowing only the initial density, the initial porosity, and the crushup density $\left(\rho_C\right)$. Both α and β increase monotonically from zero to unity along the path OC (see Fig. 4.1). In the limit as the initial porosity approaches zero, $n_0 \to 1$, $n \to 1$ and $\rho_C \to \rho_0$.

Since ρ_C will, in general, not be known for a given untested tuff, it was decided to generate an approximate expression for ρ_C as a function of "crystal" density and

initial distention,

$$\rho_c = f\left(\rho_0^e, n_0\right) . \tag{4.12}$$

For a given ρ_0^e, the value of ρ_c will increase $\left(\text{from a poreless value equal of } \rho_0^e\right)$ with increasing initial porosity (decreasing n_0). The combination of Eqs. (4.12) and (4.11) makes it possible to describe the crushup behavior of a porous dry tuff knowing only the initial density and the initial distention.

Crushup relation $\beta(\alpha)$ and crushup density function, Eq. (4.12), were evaluated from the first six dry, porous tuffs* listed in Table 4.1. The crushup density relation was obtained by passing the scaled NTS poreless tuff fit (Table 2.1) through the higher pressure p-V data points for each of the six dry porous tuffs. This established, for each tuff, a limited range of ρ_c and ρ_0^e values for each of the six tuffs. A parameter study was then made, for values of ρ_c and ρ_0^e in the limited range, which led to a fit which best reproduces the p-V data for the six tuffs. The fit is expressed by the following single relationship:

$$\rho_c = 1.06\ \rho_0^e \qquad \text{for } n_0 \leq .9525 \tag{4.13a}$$

$$\rho_c = 2.263\ \rho_0^e - 1.263\ \rho_0 \qquad \text{for } n_0 > .9525 \tag{4.13b}$$

---

*Upon close examination, the Paintbrush tuff data does not exhibit the same characteristics as the other six porous dry tuffs in Table 1. Its crushup pressure is well in excess of 50 kilobars, whereas the other six tuffs have crushup pressures below 25 kilobars. There are insufficient data available to determine the cause of the difference between Paintbrush tuff and the other six tuffs. Consequently, in developing a porous dry tuff description, we limit our attention to the first six materials in Table 4.1.

TABLE 4.1

Porous, Dry Tuffs for which Hydrostatic, Pressure-Volume Data has been Found in the Literature

Tuff Description	Reference	Density (g/cc)	Water Content (wt. %)	Void Content (wt. %)
NTS Dry	25,26	2.24	0.	$\geq$ 2.7
Fraction	27	1.761	4.9	17.0
Schooner at 41 ft	23	2.356	0.3	> 3.4
Schooner at 398 ft	23	2.306	0.3	> 5.3
Schooner at 150 ft	23	1.661	0.5	>27.0
Stoddard	23	1.466	0.	>34.0
Paintbrush	27	1.406	0.4	40.8

The $\overline{\text{NTS}}$ poreless tuff p-V, Table 2.1, and the crushup density relation, Eq. (4 13), were used to obtain α-β points corresponding to the loading data for each of the first six tuffs in Table 4.1. A parameter study was then conducted to establish the α-β curve which would best represent the data. The optimum curve is represented by the series of α-β points given in Table 4.2. Thus, the $\overline{\text{NTS}}$ poreless tuff fit, the crushup density relation and the α-β curve are used within the framework of the model presented in Section 4.2 to describe the crushup of $\overline{\text{NTS}}$ porous dry tuff.

TABLE 4.2

α-β Points used to Describe the Crushup of Porous Dry Tuff

$$\beta = \beta(\alpha),$$

$$\beta \equiv \frac{n - n_0}{1 - n_0} \qquad \alpha \equiv \frac{\rho - \rho_0}{\rho_c - \rho_0}$$

α	β	α	β
.0000	.0000	.4790	.5500
.0219	.0250	.5010	.5750
.0438	.0500	.5231	.6000
.0655	.0750	.5453	.6250
.0871	.1000	.5676	.6500
.1087	.1250	.5900	.6750
.1303	.1500	.6124	.7000
.1519	.1750	.6348	.7250
.1735	.2000	.6574	.7500
.1951	.2250	.6802	.7750
.2167	.2500	.7030	.8000
.2384	.2750	.7260	.8250
.2601	.3000	.7490	.8500
.2819	.3250	.7740	.8750
.3037	.3500	.8010	.9000
.3255	.3750	.8230	.9200
.3473	.4000	.8460	.9400
.3691	.4250	.8700	.9600
.3910	.4500	.8970	.9800
.4130	.4750	.9320	.9900
.4350	.5000	1.0000	1.0000
.4570	.5250		

The $\overline{\text{NTS}}$ porous dry tuff description was used to calculate the loading p-V curves corresponding to the hydrostatic experimental data of the first six tuffs listed in Table 4.1. Figures 4.4a through 4.4f illustrate the comparison of the calculated and experimental p-V states. The solid curve represents the $\overline{\text{NTS}}$ porous dry tuff while the experimental data are illustrated as points with deviation bars (when available). These deviation bars represent the limit of scatter for two or more experiments. The $\overline{\text{NTS}}$ description compares favorably with the Stoddard, Fraction, NTS Dry and Schooner (at 41 ft) tuff data. A slightly less favorable comparison is observed for the other two tuffs.

The $\overline{\text{NTS}}$ porous dry tuff description was next employed to calculate p-V unloading curves corresponding to the unloading experimental data for five of the six tuffs in Table 4.1 (unloading data was not available for NTS Dry tuff). Figures 4.5a through 4.5e illustrate the comparison of the calculated and experimental unloading p-V states. The solid curves illustrate the $\overline{\text{NTS}}$ porous dry tuff response with the upper curve representing the loading states and the lower curves representing the unloading states. Unloading experimental data points are plotted with the scatter bars (when available) that represent the limit of scatter for two or more experiments. The dashed lines do not represent p-V states; rather, they are merely linear connections (or tie lines) between experimental points. In general, the $\overline{\text{NTS}}$ porous dry tuff description does an adequate job of describing unloading states above 10 kbars. Below 10 kbars a majority of the data indicate some degree of void recovery while the rest of the data indicate zero void recovery and even void collapse upon unloading (Figs. 4.5b and 4.5e).

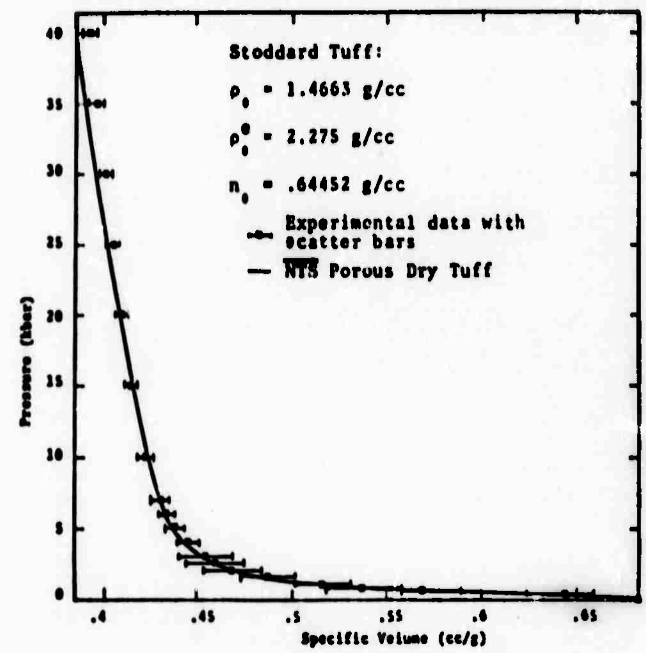

Fig. 4.4a--Comparison of calculated and experimental isothermal loading p-V states for Stoddard tuff.

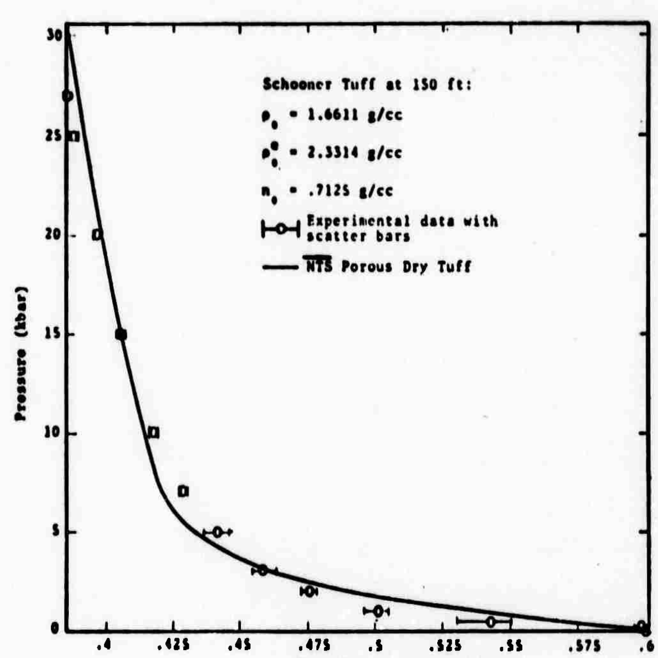

Fig. 4.4b--Comparison of calculated and experimental isothermal loading p-V states for Schooner tuff at 150 ft.

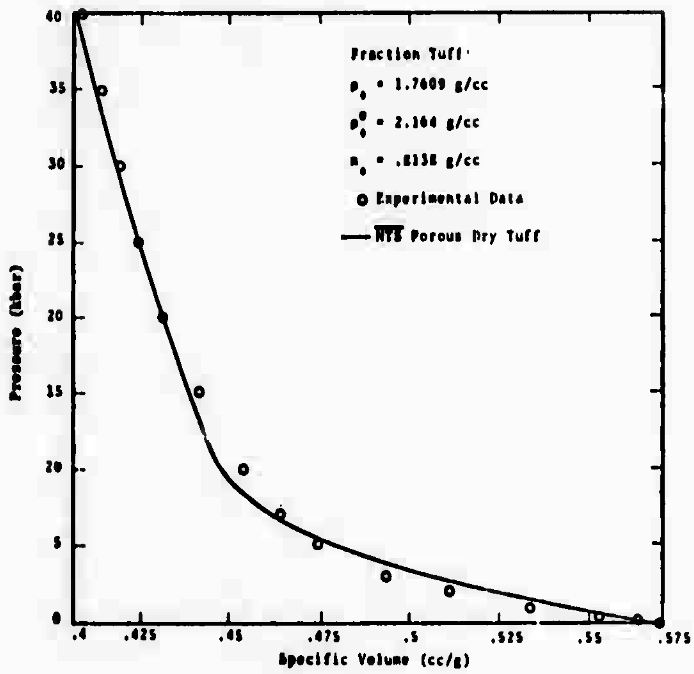

Fig. 4.4c--Comparison of calculated and experimental isothermal loading p-V states for Fraction tuff.

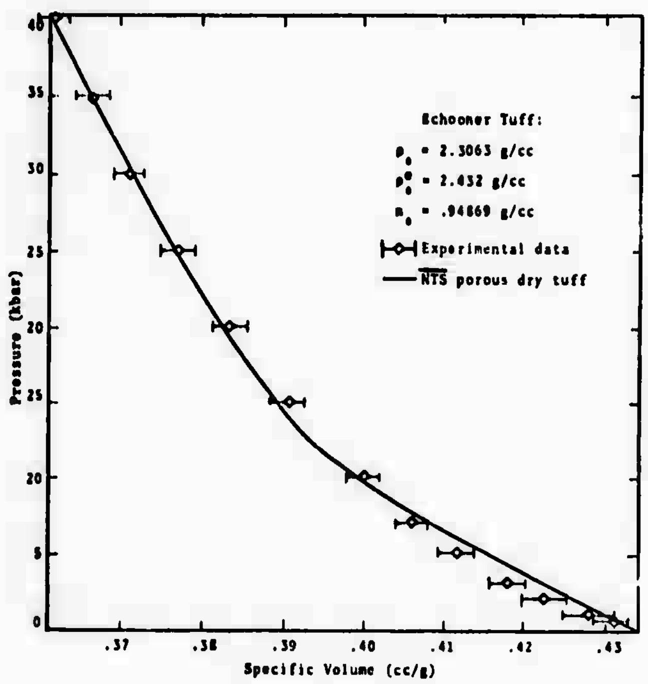

Fig. 4.4d--Comparison of calculated and experimental isothermal loading p-V states for Schooner tuff at 398 ft.

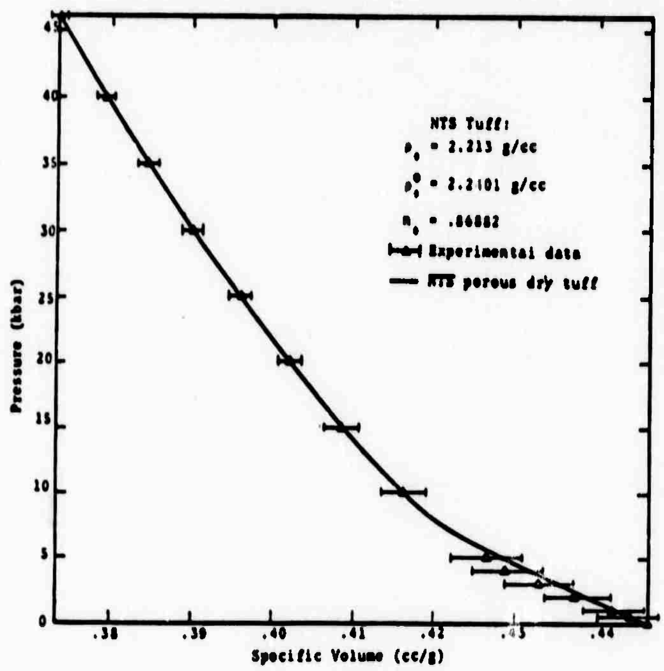

Fig. 4.4e--Comparison of calculated and experimental isothermal loading p-V states for NTS tuff.

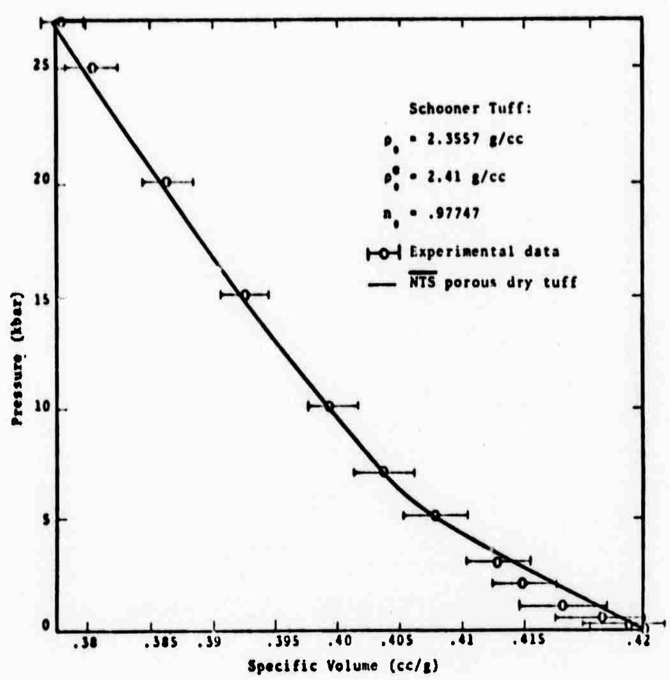

Fig. 4.4f--Comparison of calculated and experimental isothermal loading p-V states for Schooner tuff at 41 ft.

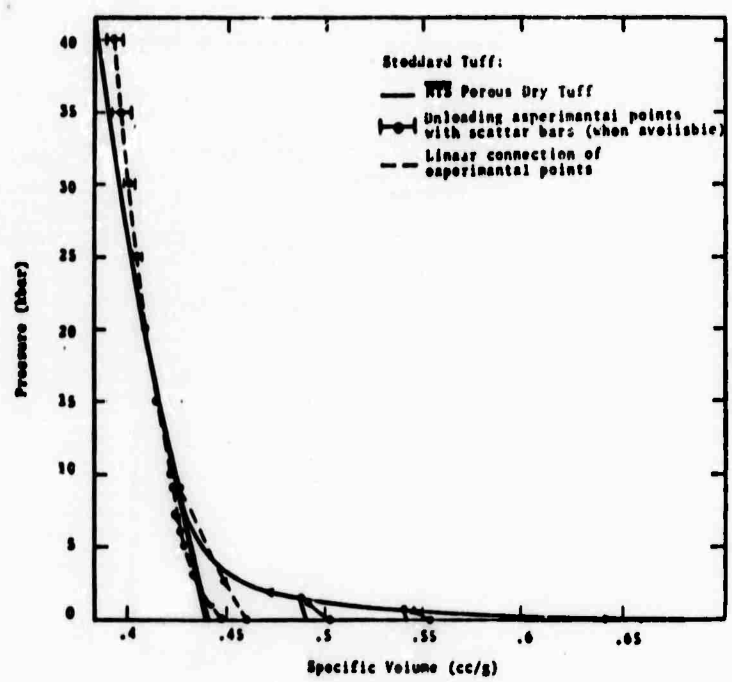

Fig. 4.5a--Comparison of calculated and experimental isothermal unloading p-V states for Stoddard tuff.

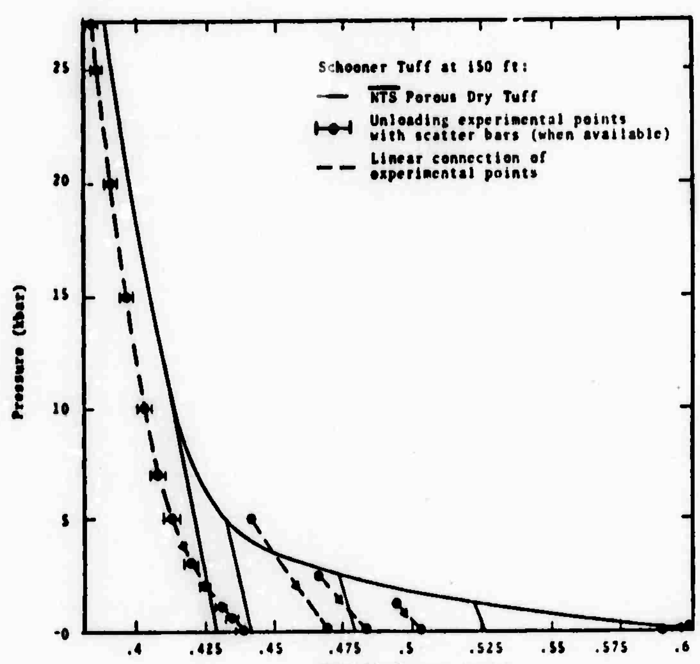

Fig. 4.5b--Comparison of calculated and experimental isothermal unloading p-V states for Schooner tuff at 150 ft.

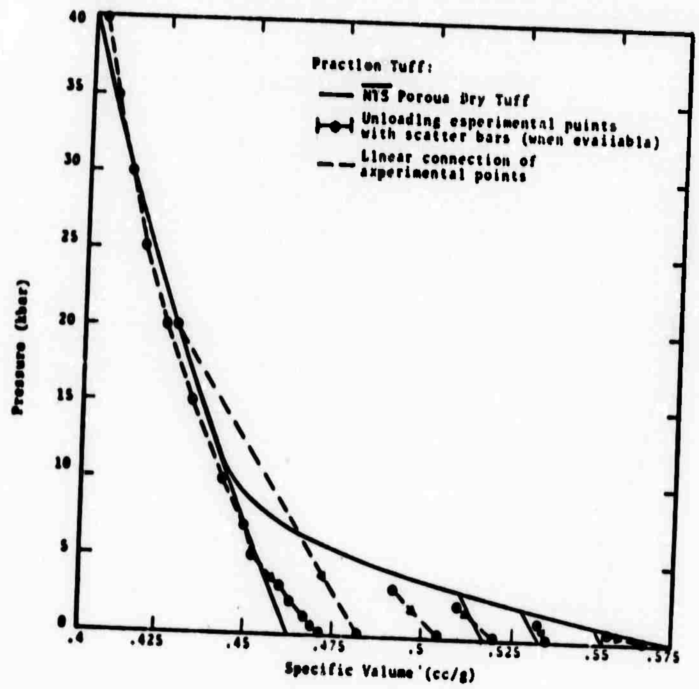

Fig. 4.5c--Comparison of calculated and experimental isothermal unloading p-V states for Fraction tuff.

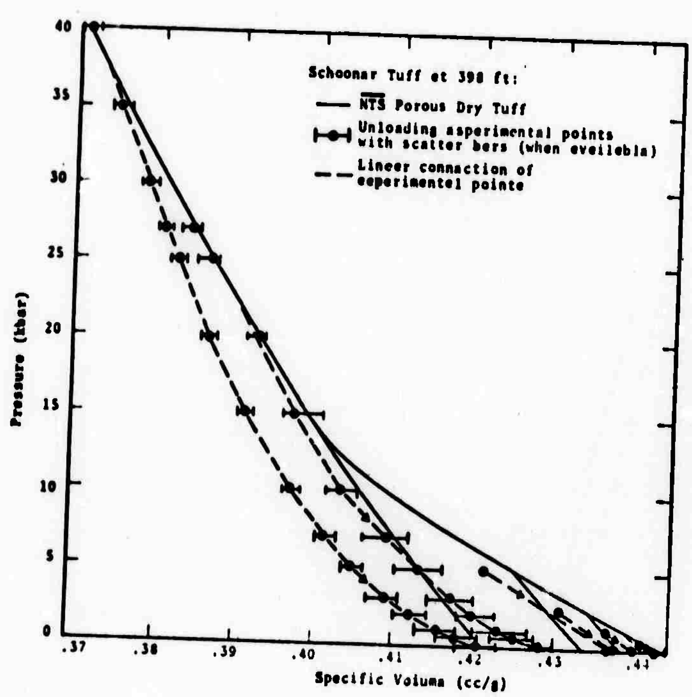

Fig. 4.5d--Comparison of calculated and experimental isothermal unloading p-V states for Schooner tuff at 398 ft.

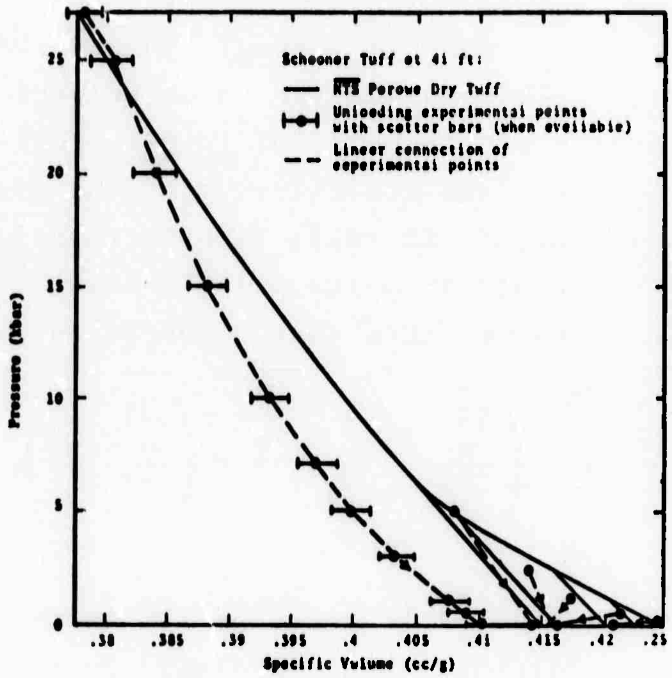

Fig. 4.5e--Comparison of calculated and experimental isothermal unloading p-V states for Schooner tuff at 41 ft.

4.3 POROUS WET TUFF ISOTHERMAL CRUSHUP MODEL

Let $\overset{(1)}{n}$, $\overset{(2)}{n}$ and $\overset{(3)}{n}$ denote the volume fractions of the poreless solid, liquid and the voids respectively. The unsaturated portion of the pores of in situ rock probably contain gas; however, the contribution of the gas pressure to the total pressure is so small (see Section 3.4) that the unsaturated portion of the pores will be assumed to be void of matter. Thus the pressure in the composite is given by

$$p(J) = \overset{(1)}{n} P_1\left(\frac{\overset{(1)}{n}}{\overset{(1)}{n}_0} \overset{(1)}{J}\right) + \overset{(2)}{n} P_2\left(\frac{\overset{(2)}{n}}{\overset{(2)}{n}_0} \overset{(2)}{J}\right), \tag{4.14}$$

where $P_1\left(\overset{(1)}{J}\right)$ and $P_2\left(\overset{(2)}{J}\right)$ describe the isotropic isothermal behavior of the isolated solid and liquid respectively and

$$\overset{(k)}{J} = \overset{(k)}{\rho}_0 / \overset{(k)}{\rho}, \qquad k = 1, 2 \tag{4.15}$$

$$\overset{(r)}{n} = \overset{(r)}{n}\left(\overset{(1)}{J}, \overset{(2)}{J}\right) \qquad r = 1, 2, 3 . \tag{4.16}$$

In quasi-static jacketed tests where net diffusion is precluded, Eq. (4.15) yields

$$J = \overset{(k)}{J} = \rho_0/\rho = \overset{(k)}{\rho}_0 / \overset{(k)}{\rho}, \quad k = 1, 2; \tag{4.17}$$

Therefore,

$$p(J) = \overset{(1)}{n} P_1\left(\frac{\overset{(1)}{n}}{\overset{(1)}{n}_0} J\right) + \overset{(2)}{n} P_2\left(\frac{\overset{(2)}{n}}{\overset{(2)}{n}_0} J\right) . \tag{4.18}$$

In the *in situ* rock, there exists a distribution of the pore sizes. Some of these may be fully saturated, others partially saturated and still others completely dry. Evaluation of functions $\overset{(r)}{n}$ requires some assumptions regarding the distribution of pores and voids. In order to simplify theoretical considerations, we introduce the following two alternative postulates:

- The pores are connected and all are partially saturated. There can be no deformation of the fluid until all the voids have been crushed out.
- There are two distinct types of pores--a set of voids and a set of fully saturated pores and the two types of pores are disconnected.

The consequences of these two postulates will be discussed in the next two sections.

4.3.1 Connected Pores Postulate

Consider a quasi-static jacketed test. The assumption is made that the void collapse, $\overset{(3)}{n}(J) \to 0$, occurs without effective deformation of the fluid. The test may then be conceptually divided into two parts.

Part 1: $\overset{(3)}{n} \neq 0$

As long as $\overset{(3)}{n}$ is non-zero, the rock is not completely saturated. The fluid is free to flow into the open spaces and no effective deformation of the fluid occurs. Therefore, from Eq. (4.18), the pressure in the mixture is determined by the isotropic relation between the effective pressure and the effective density of the poreless rock matrix, i.e.,

$$p(J) = \overset{(1)}{n} P_1\left(\frac{\overset{(1)}{n}}{\overset{(1)}{n}_0} J\right) \tag{4.19}$$

Also the condition that no effective fluid deformation occurs for $\overset{(3)}{n} \neq 0$ implies that

$$P_2\left(\frac{\overset{(2)}{n}}{\overset{(2)}{n}_0} J\right) = P_2(1) = 0$$

i.e.,

$$\frac{\overset{(2)}{n}_0}{\overset{(2)}{n}} = J . \tag{4.20}$$

Substitution of Eq. (4.20) in $\sum \overset{(r)}{n} = 1$ yields

$$\overset{(3)}{n} = 1 - \overset{(1)}{n}(J) - \overset{(2)}{n}_0/J . \tag{4.21}$$

Note that relations (4.19) through (4.21) hold until $\overset{(3)}{n} = 0$ i.e., until

$$0 = 1 - \overset{(1)}{n}\left(J_c\right) - \overset{(2)}{n}_0/J_c \tag{4.22}$$

Subsequent loading-unloading is reversible with $\overset{(3)}{n} \equiv 0$ and $\overset{(2)}{n} = 1 - \overset{(1)}{n}$.

Part 2: $\overset{(3)}{n} = 0$

The pressure is given by Eq. (4.18) along the reversible path BA depicted in Fig. 4.6. Note that at B $\left(J = J_0\right)$, we have $p = P_1 = P_2 = 0$. Hence

$$\frac{\overset{(1)}{n}}{\overset{(1)}{n}_0} J_0 = 1 \tag{4.23a}$$

and

$$\frac{1 - \overset{(1)}{n}}{\underset{0}{\overset{(2)}{n}}} J_0 = 1 \tag{4.23b}$$

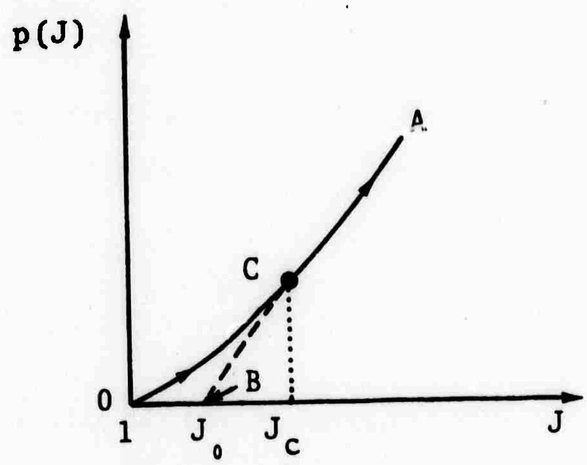

Fig. 4.6--Schematic of crushup behavior of a partially saturated porous rock.

Equations (4.23) yield

$$J_0 = \overset{(2)}{n}_0 + \overset{(1)}{n}_0 = 1 - \overset{(3)}{n}_0 \; . \tag{4.24}$$

This last relation determines the initial void volume fraction. In order to evaluate $\overset{(1)}{n}(J)$ along OC, and hence $\overset{(3)}{n}(J)$ from Eq. (4.21), we need in addition to p(J) (given by OC), the functional form for $P_1(J)$--pressure law for poreless solid rock matrix. Again to determine $\overset{(1)}{n}$ $\left(\text{and hence } \overset{(2)}{n} \equiv 1 - \overset{(1)}{n}\right)$ along BCA, we need in addition to p(J) (given by BCA), the functional forms for $P_1(J)$ and $P_2(J)$--pressure laws for solid and fluid. Note that it is not permissible to use effective pressure equilibrium to eliminate the need for $P_1(J)$ or $P_2(J)$ in the vicinity of C along OC. The fluid

experiences no pressure up to point C and the imposition of a sudden pressure equilibrium at C would lead to a discontinuous jump in fluid pressure which is physically unrealistic. Hence, a description of continuous fluid pressurization in the vicinity of C along OC needs to be formulated. Such a description could be based on the transfer of pressure from a trapped gas to the fluid. (See Section 3.4 for a discussion of the pressurization of the trapped gas.)

In quasi-static deformation, the fluid plays no part as long as $\overset{(3)}{n} = 0$. How about wave propagation? The fluid will be pressurized if

$$\overset{(2)}{n}\left(\overset{(1)}{J}, \overset{(2)}{J}\right) < \overset{(2)}{n}_0 / \overset{(2)}{J} \ . \tag{4.25}$$

(Equation (4.25) merely implies effective fluid deformation.) In the quasi-static case, $\overset{(2)}{n}$ is given by

$$\overset{(2)}{n} = \overset{(2)}{N}(J) = \overset{(2)}{n}_0 / J \tag{4.26}$$

For wave propagation, we approximate $\overset{(2)}{n}\left(\overset{(1)}{J}, \overset{(2)}{J}\right)$ by

$$\overset{(2)}{n}\left(\overset{(1)}{J}, \overset{(2)}{J}\right) = \overset{(2)}{N}\left[\frac{1}{2}\left(\overset{(1)}{J} + \overset{(2)}{J}\right)\right] = \frac{2\,\overset{(2)}{n}_0}{\overset{(1)}{J} + \overset{(2)}{J}} \tag{4.27}$$

Combining Eqs. (4.25) and (4.27) yields the result that for fluid deformation (effective), we must have

$$\overset{(2)}{J} > \overset{(1)}{J}$$

or

$$\overset{(2)}{\rho}_0 / \overset{(2)}{\rho} > \overset{(1)}{\rho}_0 / \overset{(1)}{\rho} \tag{4.28}$$

Equation (4.28) implies more "partial" deformation of the solid. This will arise if the bulk modulus of the fluid is greater than that of the solid. If, however, bulk modulus of the solid is greater than that of the fluid, then the solid alone carries the stress until complete void collapse.

4.3.2 Disconnected Pores Postulate

In this case, the pores are assumed to consist of two distinct unconnected sets--a set of voids and a set of fully saturated pores. In contradistinction to the case of connected pores where the fluid was assumed to undergo no effective deformation prior to total void collapse, the fluid in this model is pressurized from the beginning. Voids $\left(\overset{(3)}{n}\right)$ are completely surrounded by the compacted solid and do not delay fluid pressurization. The mixture pressure p(J), is given by

$$p(J) = \overset{(1)}{n} P_1\left(\frac{\overset{(1)}{n}}{\overset{(1)}{n}_0} \; \overset{(1)}{J}\right) + \overset{(2)}{n} P_2\left(\frac{\overset{(2)}{n}}{\overset{(2)}{n}_0} \; \overset{(2)}{J}\right) \qquad (4.29)$$

with

$$\overset{(2)}{n} = 1 - \overset{(1)}{n} - \overset{(3)}{n} \quad \text{along OC (Fig. 4.6)}$$

and

$$\overset{(2)}{n} = 1 - \overset{(1)}{n} \quad \text{along CACB.}$$

Note that the void fraction $\overset{(3)}{n}$ is a function of $\overset{(1)}{J}$ only and does not depend upon $\overset{(2)}{J}$. The function $\overset{(3)}{n}\left(\overset{(1)}{J}\right)$ can be determined from quasi-static tests on dry porous tuff as described in Section 4.2. For quasi-static jacketed tests $\left(\overset{(1)}{J} = \overset{(2)}{J} = J\right)$, one can introduce the assumption of pressure

equilibrium between distended tuff and water

$$p(J) = \frac{n^{(1)}}{n^{(1)} + n^{(3)}} P_1\left(\frac{n^{(1)}}{n_0^{(1)}} J\right) = P_2\left(\frac{n^{(2)}}{n_0^{(2)}} J\right) \tag{4.30}$$

to determine the unknown function $n^{(1)}(J)$. It is easily seen that the formulation for the case of disconnected pores is considerably simpler (in that it requires less information) than the corresponding analysis for connected pores. The application of the distinct pores postulate to porous wet tuffs will be discussed in the next section.

4.3.3 Application of Disconnected Pores Postulate

The disconnected pores postulate assumes the wet, porous tuff to consist of a set of voids and a set of fully saturated pores with no connection between the two such that the water can flow into the voids. Another way of describing this postulate is to imagine that the porous wet tuff is a two-component system composed of water [designated (2)] and porous dry tuff [designated (1*)]. Alternatively, the pores may well be connected but the time available under shock loading may be insufficient for effective flow from pore to pore.

The assumption of pressure equilibrium, as introduced in Section 4.3.2, equates the effective pressure of the water, given by

$$p = P_2^{(2)}(\mu) = A_2^{(2)} \mu + B_2^{(2)} \mu^2 + F_2^{(2)} \mu^3 \tag{4.31}$$

to the effective pressure of the porous "dry" tuff (1*),

given by

$$p = \overset{(1^*)}{n}\, P_1(\overset{(1)}{\mu}) = \overset{(1^*)}{n}\left[A_1 \overset{(1)}{\mu} + B_1 \overset{(1)}{\mu}{}^2 + F_1 \overset{(1)}{\mu}{}^3\right] . \tag{4.32}$$

Here

$$\overset{(r)}{\mu} = \frac{\overset{(r)}{n}_0 \overset{(r)}{\rho}}{\overset{(r)}{n}\, \overset{(r)}{\rho}_0} - 1 = \frac{\overset{(r)}{n}_0}{\overset{(r)}{n}\, \overset{(r)}{J}} - 1 \quad (r = 1,\ 2), \tag{4.33a}$$

$$\overset{(1^*)}{n} \equiv \frac{\overset{(1)}{V}}{V - \overset{(2)}{V}} = \frac{\overset{(1^*)}{\rho}}{\overset{(1)}{\rho}{}^{e}} = \frac{\overset{(1)}{n}}{\overset{(1)}{n} + \overset{(3)}{n}} \tag{4.33b}$$

By substituting $\overset{(2)}{n} = \left(\overset{(1^*)}{n} - \overset{(1)}{n}\right)/\overset{(1^*)}{n}$ [from Eq. (4.33b)] into Eq. (4.31) and equating it to Eq. (4.32), we have one equation with two unknowns, $\overset{(1)}{n}$ and $\overset{(1^*)}{n}$, i.e.,

$$\overset{(1^*)}{n}\, P_1\left(\overset{(1)}{\mu}\right) = P_2\left(\frac{\overset{(2)}{n}_0\, \overset{(1^*)}{n}}{\left(\overset{(1^*)}{n} - \overset{(1)}{n}\right)\overset{(2)}{J}} - 1\right) . \tag{4.34}$$

The void collapse of the porous "dry" tuff component is given by a table of α, β points (see Section 4.2.2):

$$\alpha \equiv \frac{\overset{(1^*)}{\rho} - \overset{(1^*)}{\rho}_0}{\rho_C - \overset{(1^*)}{\rho}_0} , \qquad \beta \equiv \frac{\overset{(1^*)}{n} - \overset{(1^*)}{n}_0}{1 - \overset{(1^*)}{n}_0} \tag{4.35}$$

The crushup density, ρ_C, is given by the empirical equation (Section 4.2.2)

$$\rho_C = a\, \overset{(1)}{\rho}_0{}^{e} + b\, \overset{(1^*)}{\rho}_0 \tag{4.36}$$

By substituting $\overset{(1*)}{\rho} = \left(\overset{(1)}{\rho}\overset{(1*)}{n}\right)/\overset{(1)}{n}$ into the α identity, relation β = Table (α) can be written as

$$\frac{\overset{(1*)}{n} - \overset{(1*)}{n}_0}{1 - \overset{(1*)}{n}_0} = \text{Table}\left[\left(\frac{\overset{(1)}{\rho}\overset{(1*)}{n}}{\overset{(1)}{n}} - \overset{(1*)}{\rho}_0\right)\Big/\left(\rho_C - \overset{(1*)}{\rho}_0\right)\right]. \quad (4.37)$$

A double iteration method is used to solve Eqs. (4.34) and (4.37) for the unknown functions $\overset{(1)}{n}$ and $\overset{(1*)}{n}$. After the voids are removed $\left(\overset{(3)}{n} = 0, \overset{(1)}{n} + \overset{(2)}{n} = 1\right)$, we are left with only one unknown function, $\overset{(1)}{n}$, which can be obtained from Eqs. (4.34).

The porous wet tuffs for which isothermal data are available are summarized in Table 4.3. The $\overline{\text{NTS}}$ porous wet tuff model, computed under the disconnected pores postulate as described above, was used to compute p-V isothermal states corresponding to three tuffs selected from Table 4.3. The three tuffs (wet NTS Tuff, Schooner at 154 ft and Schooner at 304 ft) represent a wide variation in water and void content. The data for these three materials show the water phase changes (liquid to Ice VI and Ice VI to Ice VII) take place at pressures corresponding roughly to isolated water compression data. These phase changes have not been included in the $\overline{\text{NTS}}$ porous wet tuff model; therefore, we will limit our interest to isothermal states with pressures below the first phase change ($p < 10$ kbar).

Figures 4.7a to 4.7c compare the loading and unloading data of the three selected tuffs with three corresponding calculations based on the $\overline{\text{NTS}}$ porous wet tuff model. The comparison with the wet $\overline{\text{NTS}}$ tuff (Fig. 4.7a) is quantitatively poor due, most probably, to a significantly different geologic composition. The $\overline{\text{NTS}}$ porous wet tuff loading states in Figs. 4.7b and 4.7c lie consistently above the measured data. The two most

TABLE 4.3

Porous Wet Tuffs for which Isothermal Data are Available

Description	Reference	Density g/cc	(1) n cc/cc	(2) n cc/cc	(3) n cc/cc
Wet NTS Tuff	27	2.083	.67	.31	.02
Hudson Seal at 18 ft	23	1.697	.471	.510	.019
Hudson Seal at 53 ft	23	1.977	.689	.284	.027
Hudson Seal at 154 ft	23	1.858	.60	.38	.02
Schooner at 154 ft	23	1.766	.60	.15	.25
Schooner at 304 ft	23	1.604	.44	.44	.12
Diamond Dust 4a at 138 ft	28	1.79	.617	.286	.097

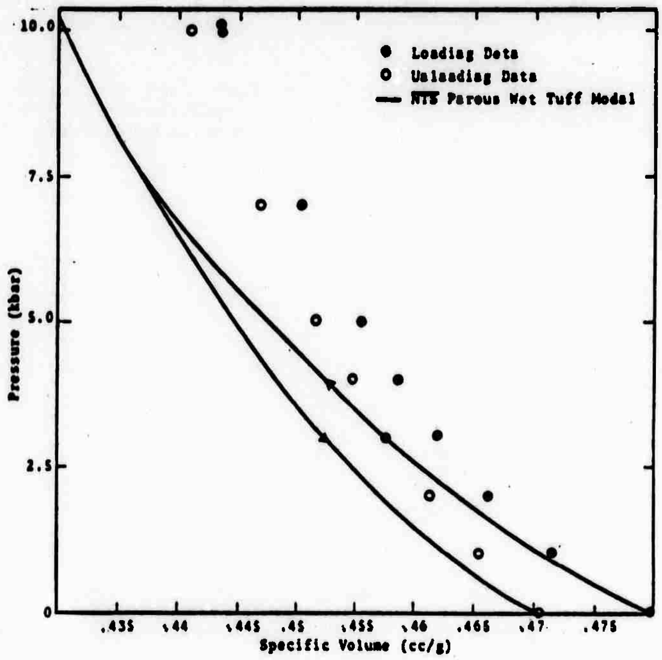

Fig. 4.7a--Comparison between experimental data for wet NTS tuff and calculated states for NTS porous wet tuff.

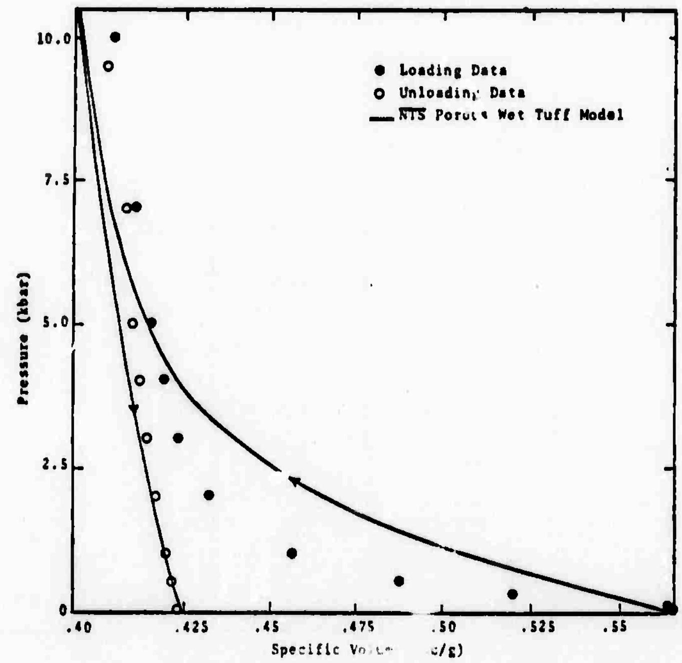

Fig. 4.7b--Comparison between experimental data for Schooner tuff at 154 ft and calculated states for NTS porous wet tuff.

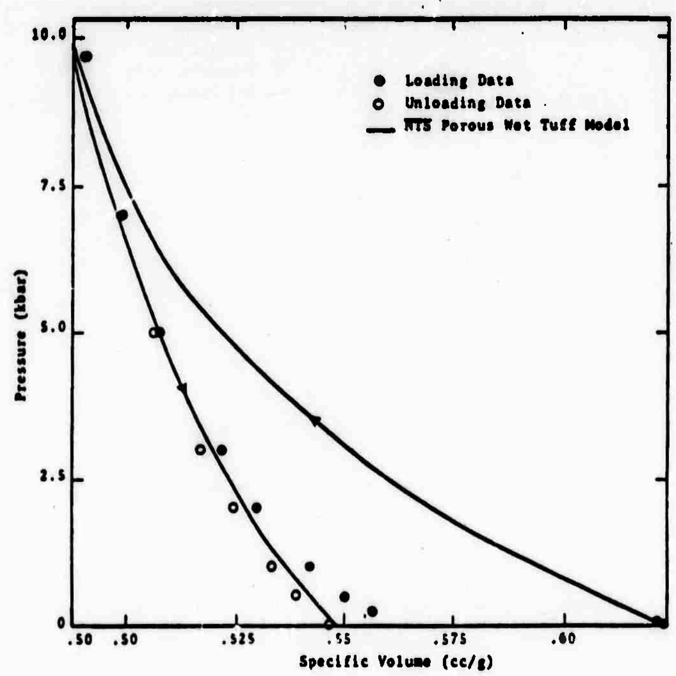

Fig. 4.7c--Comparison between experimental data for Schooner tuff at 304 ft and calculated states for NTS porous wet tuff.

likely mechanisms for explaining this discrepancy are (1) the loading rate is low enough to allow the fluid to diffuse into the voids, thus violating the disconnected pore postulate, and (2) the water reduces the strength of the rock matrix by acting as a lubricant, and/or by softening the clay components; thus the NTS porous dry tuff p-V response is inappropriate for use as the wet tuff component.

The first mechanism is likely to be significant since the pores must be connected in order for the water to get into the pores in the first place. The experimental loading rate of 1 kbar/min* allows the water ample time to relieve the pressure on it by flowing into a void. Thus, it would appear that the connected pores postulate should be used when predicting low strain rate response. However, as was pointed out earlier, the disconnected pores postulate may very well be the appropriate one when considering shock wave response.

Figure 4.8 presents a comparison between the two porous wet postulates, the dry crushup and the completely saturated response. The increase in density (decrease in specific volume) with increasing saturation results from adding mass without increasing the volume by putting the water into the pores. The connected pores postulate crushup curve lies below the disconnected pores postulate because the partial pressure on the water is relieved when it flows into the empty pores. Since the total pressure p is a sum of the partial pressures of the water and the porous dry matrix, the connected pores pressure is less than the disconnected pores pressure at a given specific volume. The rapid increase in the slope of the connected pores curve as it

*Private communication with D. R. Stephens of LRL.

approaches the poreless curve is due to the pressurization of the water by the trapped gas as the last of the voids are removed. Note that both postulates have the same p_c, ρ_c pressure equilibrium state.

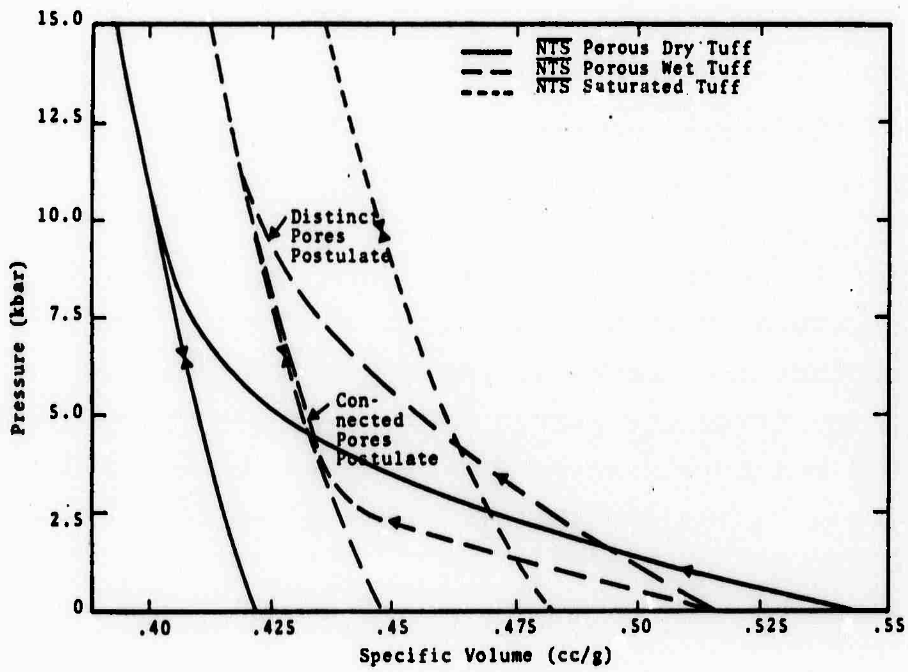

Fig. 4.8--The $\overline{\text{NTS}}$ porous wet tuff crushup curve based on the Connected Pore Postulate is only estimated. All other curves are calculated from the models described.

Reduction in the matrix strength may be even more significant. Through capillary action, the water could form a thin film over a solid particle in the tuff and thus reduce the friction forces between it and neighboring particles. This would allow the grain to relieve the forces acting on it by slipping over the neighboring grains and into a void. It has also been demonstrated[27] that a substantial amount of the water combines

chemically with the clay components of the tuff. This phenomenon changes the character of the clay such that it can behave plastically at pressures far below those required to fracture it in its dry state. Thus the wet clay is able to relieve the forces acting on it by flowing into the nearby voids. This phenomenon was examined by arbitrarily lowering the value of the crushup density in the $\overline{\text{NTS}}$ porous wet model, thus effecting a decrease in the crushup strength of the dry rock matrix. Pressure-volume states computed with the weakened model are compared with the data for Schooner tuff at 304 ft in Fig. 4.9. Note the significant improvement by comparing Fig. 4.9 with Fig. 4.7c.

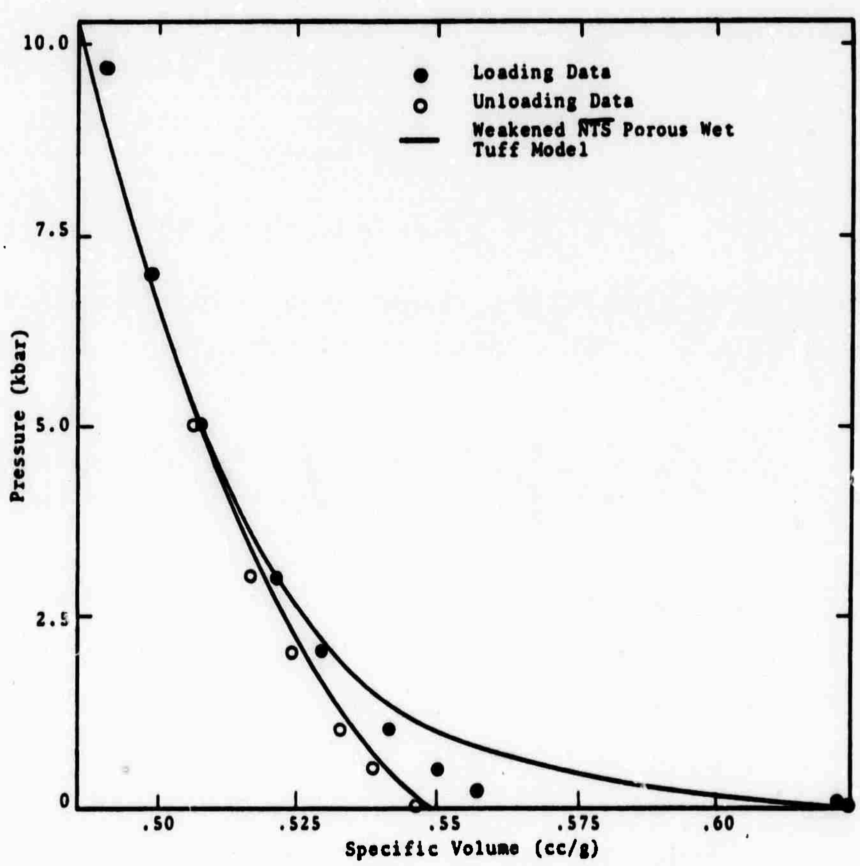

Fig. 4.9--Comparison between experimental data for Schooner tuff at 304 ft and calculated states for weakened $\overline{\text{NTS}}$ porous wet tuff.

4.4 THERMODYNAMIC CRUSHUP MODEL

In the following, we outline the development of a thermodynamic crushup model for $\overline{\text{NTS}}$ porous dry tuff. The model for a wet porous tuff is currently under development.

A pressure equation of state for $\overline{\text{NTS}}$ poreless tuff was previously (3SR-267) developed in the Mie-Gruneisen form. It relates pressure, p^e, to density, ρ^e, and specific internal energy, E^e, i.e.,

$$p^e = P_H \left(1 - .5G\left(\frac{\rho^e}{\rho_0^e} - 1\right)\right) + G\rho^e E^e$$

where (4.38)

$$P_H = A\left(\frac{\rho^e}{\rho_0^e} - 1\right) + B\left(\frac{\rho^e}{\rho_0^e} - 1\right)^2 + F\left(\frac{\rho^e}{\rho_0^e} - 1\right)^3$$

and

A, B, F and G are constants (Table 2.1)

The associated temperature equation of state relates the temperature, T, to the specific volume, $V^e = 1/\rho^e$, and E^e,

$$T = T_0 + \left[E^e - E_0^e + \int_{V_0^e}^{V^e} h_1(V^e)\, dV^e\right] \Big/ C_V \qquad (4.39)$$

where C_V is the specific heat at constant volume, and the integral represents the compression energy which is computed from a polynomial in V^e. C_V is assumed to be a constant.

In developing a crushup model for a porous solid, we assume that the pores are devoid of matter, and all of the energy is absorbed by the solid. Therefore, the specific internal energy of the porous solid is equal to that of the poreless solid, i.e.,

$$E = E^e \qquad (4.40)$$

On introducing the volume scaling factor, $n\left(= \frac{(1)}{n}\right)$, the pressure equation of state for $\overline{\text{NTS}}$ porous dry tuff becomes:*

$$p = n\, P_H \left(1 - .5G\left(\frac{n_0}{n}\frac{\rho}{\rho_0} - 1\right)\right) + G\rho(E-E_0) \quad (4.41)$$

where

$$P_H = A\left(\frac{n_0}{n}\frac{\rho}{\rho_0} - 1\right) + B\left(\frac{n_0}{n}\frac{\rho}{\rho_0} - 1\right)^2 + F\left(\frac{n_0}{n}\frac{\rho}{\rho_0} - 1\right)^3 .$$

Since the energy per unit mass of the porous material is equal to the specific energy of the poreless solid, the temperature of the porous material is equal to the temperature of the solid. Thus, the porous temperature equation of state is simply

$$T = T_0 + \left[E - E_0 + \int_{n_0V_0}^{nV} h_1(nV)\, d(nV)\right] \Big/ C_V \quad (4.42)$$

where the integral is now a polynomial in nV.

Two assumptions are made in the development of the crushup density equation:

1. Thermal softening does not take place.
2. The crushup pressure, p_c, is independent of energy.

These assumptions are not, however, crucial. Given experimental data describing the energy dependence of the crushup pressure, an empirical equation incorporating the dependence of the crushup pressure on energy can be introduced.

In Section 4.2.2, an empirical equation was developed for the 20°C isothermal crushup density, ρ_c. The crushup pressure, p_c, corresponding to 20°C isothermal crushup density, ρ_c, is obtained by substituting

*See Section 5.2 for derivation of the scaling function on which Eq. (4.41) is based.

$$n = 1, \ \rho = \rho_c, \quad V = 1/\rho_c \quad T = T_0 = 20°C$$

in Eq. (4.41) and (4.42),

$$p_c = P_H \left[1 - .5G\left(\frac{\rho_c}{\rho_0^e} - 1\right)\right] + G\rho_c \left[-\int_{n_0 V_0}^{V_c} h_1(nV)\ d(nV)\right] \tag{4.43}$$

where

$$P_H = A\left(\frac{\rho_c}{\rho_0^e} - 1\right) + B\left(\frac{\rho_c}{\rho_0^e} - 1\right)^2 + F\left(\frac{\rho_c}{\rho_0^e} - 1\right)^3 .$$

Once the crushup pressure is known, the crushup density for any value of E, ρ_{cE}, can be computed from the pressure equation of state (Eq. 4.41) by setting $p = p_c$, $n = 1$, and E equal to the specific energy of interest.

The variation of the volume scaling function, n, with density and energy describes the void collapse or crushing process. In Section 4.2.2, the crushup of $\overline{\text{NTS}}$ porous dry tuff was described by the functional relationship $\beta = f(\alpha)$. Assuming that the same relationship describes the thermodynamic crushup process, the function, α, has the form:

$$\alpha = \frac{\rho - \rho_{0E}}{\rho_{cE} - \rho_{0E}} \tag{4.44}$$

The volume fraction n is a function of the bulk density, ρ, the energy dependent crushup density, ρ_{cE}, the energy dependent initial density, ρ_{0E}, and the initial porosity represented by n_0. The value of ρ_{0E} is computed from the pressure equation of state by setting $p = 0$, $n = n_0$ and E equal to the specific energy of interest.*

*It may be necessary to reassess the applicability of the present $\overline{\text{NTS}}$ tuff equation of state for low pressure, expanded states.

$$0 = GE\rho_0^e + \kappa\left(An_0 + GE\rho_0^e\right) + \kappa^2\left(Bn_0 - .5\ GAn_0\right)$$
$$+ \kappa^3\left(Fn_0 - .5GBn_0\right) - .5GFn_0\kappa^4 \qquad (4.45)$$

where

$$\kappa \equiv \left(\rho_{0E}/\rho_0^e\right) - 1\ .$$

A schematic illustration of the calculation of the "thermal" crush curve is given in Fig. 4.10. The heavy solid curves in Fig. 4.10 represent the porous Hugoniot shock states as computed from the pressure equation of state (Eq. 4.41) and the Hugoniot equation

$$E = E_0 + .5(p + p_0)(V_0 - V)\ . \qquad (4.46)$$

The "thermal" crush curve represents the Hugoniot states for the bulk material (solid plus voids). The corresponding states of the crystalline material are represented by the thermal reference curve. For comparison the Hugoniot states of poreless $\overline{\text{NTS}}$ tuff (dashed curves) and the hydrostatic reference and crush curves (light lines) are included.

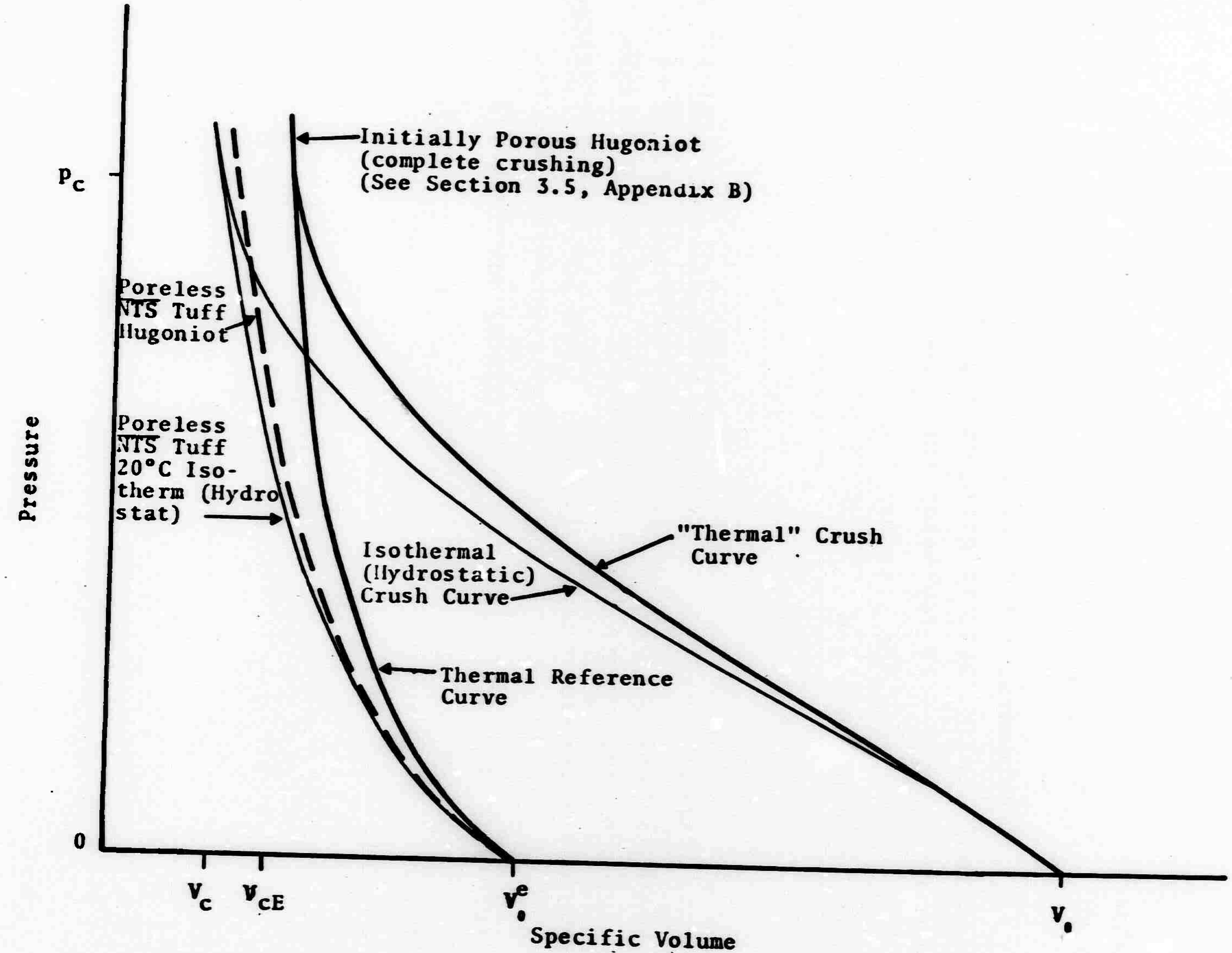

Fig. 4.10--Schematic of the pressure-density states for the $\overline{\text{NTS}}$ porous dry tuff with thermal effects included.

V. TINC DEVELOPMENT AND APPLICATIONS

5.1 BACKGROUND

In 3SR-267, constitutive relations were presented for an elastic-plastic fluid-saturated porous solid within a mechanical TINC framework (no explicit energy dependence). The composite model was formulated by assuming that the constitutive law for each $\overset{(\alpha)}{s}$ as a single continuum relates $\overset{(\alpha)}{\sigma}{}^{e}$ to $\overset{(\alpha)}{\rho}{}^{e}$ and the isochoric (constant volume) deformation associated with the constituent displacement field $\overset{(\alpha)}{\underline{u}}$, the latter unchanged by volume scaling. This formulation has already been applied in the previous chapter to develop models for the irreversible crushup of porous rocks. For the sake of completeness, however, we will start this chapter with a self-contained presentation of the formulation (Section 5.2). In Section 5.3, we present stress pulse propagation calculations for a saturated wet tuff medium. The results using the TINC formulation are compared to those obtained using a simple homogenized model of the wet tuff medium. The $\overline{\text{NTS}}$ porous dry tuff model developed in Chapter IV is employed in Section 5.4 to study stress wave propagation through a porous medium. Simple extensions of the basic TINC model to include (a) the effect of confining and pore pressures and (b) non-Darcian flow are discussed in Section 5.5. During this past year, work has been also initiated towards (a) developing more realistic soil plasticity models, and (b) extending the TINC model to a thermodynamic material. These efforts are briefly reviewed in Section 5.6.

5.2 REVIEW OF TINC FORMULATION

5.2.1 Basic Model Development

In developing the TINC model, we restrict our attention to simple materials exhibiting no explicit time dependence in their response. For a simple material the stress $\overset{(\alpha)}{\tilde{\sigma}}{}^e$ depends only on the current deformation gradient $\overset{(\alpha)}{\tilde{F}}{}^e$ with respect to some reference configuration. Let $\overset{(\alpha)}{\underline{X}}$ denote an $\overset{(\alpha)}{s}$ particle position in the reference configuration. Then in rectangular Cartesian spatial coordinates x_i $(i = 1, 2, 3)$, the motion of $\overset{(\alpha)}{s}$ is described by

$$x_i = \overset{(\alpha)}{\chi}\left(\overset{(\alpha)}{\underline{X}}, t\right) \tag{5.1}$$

and the deformation gradient is

$$\overset{(\alpha)}{F}_{ij} = \frac{\partial \overset{(\alpha)}{x}_i}{\partial \overset{(\alpha)}{X}_j} = \delta_{ij} + \frac{\partial \overset{(\alpha)}{u}_i}{\partial \overset{(\alpha)}{X}_j} \tag{5.2}$$

where δ_{ij} is the Krönecker delta. We also have (see Truesdell[29]) from mass conservation

$$\overset{(\alpha)}{\rho}\,\overset{(\alpha)}{J} = \overset{(\alpha)}{\rho}_0 , \tag{5.3a}$$

where $\overset{(\alpha)}{\rho}_0$ is the initial partial density and

$$\overset{(\alpha)}{J} = \left|\det\left(\overset{(\alpha)}{\tilde{F}}\right)\right| > 0 \tag{5.3b}$$

is the Jacobian of the deformation. A partial density preserving deformation satisfies

$$\overset{(\alpha)}{J} \equiv 1 \tag{5.4}$$

Now, it is convenient to regard the deformation $\overset{(\alpha)}{\underset{\sim}{F}}$ as a density preserving deformation $\overset{(\alpha)}{\underset{\sim}{F}}{}^{*}$ followed by a uniform dilatation. Thus,

$$\overset{(\alpha)}{\underset{\sim}{F}} = \left(\overset{(\alpha)}{J}\right)^{1/3} \underset{\sim}{1}\, \overset{(\alpha)}{\underset{\sim}{F}}{}^{*} = \left\{\overset{(\alpha)}{J}\right\}^{1/3} \overset{(\alpha)}{\underset{\sim}{F}}{}^{*} , \tag{5.5}$$

where $\underset{\sim}{1}$ is the unit tensor. $\overset{(\alpha)}{F}{}^{*}$ is uniquely defined by Eq. (5.5) and by construction measures the shear deformation. The effective deformation $\overset{(\alpha)}{F}{}^{e}$ is defined by

$$\overset{(\alpha)}{\underset{\sim}{F}}{}^{e} = \left\{\overset{(\alpha)}{J}{}^{e}\right\}^{1/3} \overset{(\alpha)}{\underset{\sim}{F}}{}^{*} = \left\{\frac{\overset{(\alpha)}{n}}{\overset{(\alpha)}{n}_{0}}\right\}^{1/3} \overset{(\alpha)}{\underset{\sim}{F}} \tag{5.6}$$

Then, if the constitutive law for $\overset{(\alpha)}{s}$ as a single continuum is given by

$$\underset{\sim}{\sigma} = g_{\alpha}(\underset{\sim}{F}) \tag{5.7}$$

where the response function g_{α} applies to a reference configuration with initial density ρ_{0}, within the composite the constitutive law for $\overset{(\alpha)}{s}$ is expressed by

$$\overset{(\alpha)}{\underset{\sim}{\sigma}} = \overset{(\alpha)}{n}\, g_{\alpha}\left\{\left(\frac{\overset{(\alpha)}{n}}{\overset{(\alpha)}{n}_{0}}\right)^{1/3} \overset{(\alpha)}{\underset{\sim}{F}}\right\} \tag{5.8}$$

Thus, for example, an ideal fluid in isolation satisfies the constitutive law

$$\underset{\sim}{\sigma} = - P_\alpha\left(\rho_0/\rho\right)\underset{\sim}{1} = - P_\alpha(J)\ 1 \tag{5.9}$$

Therefore within the composite the law becomes

$$\overset{(\alpha)}{\underset{\sim}{\sigma}} = - \overset{(\alpha)}{n}\ P_\alpha\left(\frac{\overset{(\alpha)}{n}}{\overset{(\alpha)}{n_0}}\ \overset{(\alpha)}{J}\right)\underset{\sim}{1}\ . \tag{5.10}$$

We consider the solid to be ideally elastic-plastic* such that the allowed shear stress is restricted and only elastic dilatation (no plastic compaction) can take place. For uni-axial strain and spherically symmetric deformation, it is sufficient to postulate a yield criterion. In both cases, there are two non-vanishing principal stresses, σ_1 in the longitudinal (or radial) direction and $\sigma_2 = \sigma_3$ in the lateral directions, together with the principal stretch λ_1 in the longitudinal (or radial) direction and equal lateral stretches $\lambda_2 = \lambda_3$ (= unity in uniaxial strain). In this case, both the Tresca and von Mises yield criteria reduce to

$$s\left(\sigma_2 - \sigma_1\right) = Y \qquad s = \pm 1 \tag{5.11}$$

where Y is the maximum stress that the material can withstand in simple compression. The elastic relation between mean stress and dilatation is given by

$$\frac{1}{3}\left(\sigma_1 + 2\sigma_2\right) = - P(J) \tag{5.12}$$

It holds through both elastic and plastic deformations. To complete our description, we require an elastic shear law to replace Eq. (5.11) during elastic response when $\left|\sigma_2 - \sigma_1\right| < Y$

*More general models are described in Section 5.6.

or for unloading from yield states. It is postulated in the incremental form

$$d\left(\sigma_1 - \sigma_2\right) = 2\mu d\left(\lambda_1 - \lambda_2\right) \tag{5.13}$$

where μ denotes the shear modulus and is a constant.

By Eq. (5.6), the effective deformation gradient is given by

$$\overset{(\alpha)}{\underset{\sim}{F}}{}^{e} = \left(\frac{\overset{(\alpha)}{n}}{\overset{(\alpha)}{n}_0}\right)^{1/3} \begin{pmatrix} \lambda_1 & & \\ & \lambda_2 & \\ & & \lambda_3 \end{pmatrix} \tag{5.14}$$

In uniaxial strain (strain in the x-direction) we have

$$\lambda_x = \overset{(\alpha)}{J} = \lambda, \qquad \lambda_y = \lambda_z = 1 \tag{5.15}$$

Therefore, the plastic laws in the composite become:

$$s\left(\overset{(\alpha)}{\sigma}_y - \overset{(\alpha)}{\sigma}_x\right) = \overset{(\alpha)}{n}\, Y_{\iota}, \qquad s = \pm 1 \tag{5.16}$$

where Y_α is the uniaxial compressive strength of $\overset{(\alpha)}{s}$ in isolation, and

$$\left(\frac{1}{3}\right)\left(\overset{(\alpha)}{\sigma}_x + 2\,\overset{(\alpha)}{\sigma}_y\right) = -\,\overset{(\alpha)}{n}\, P_\alpha\left(\frac{\overset{(\alpha)}{n}}{\overset{(\alpha)}{n}_0}\,\lambda\right) \tag{5.17}$$

The elastic laws in the composite are given by Eq. (5.17) and

$$d\left(\frac{\overset{(\alpha)}{\sigma}_x - \overset{(\alpha)}{\sigma}_y}{\overset{(\alpha)}{n}}\right) = 2\mu_\alpha\, d\left[\left(\frac{\overset{(\alpha)}{n}}{\overset{(\alpha)}{n}_0}\right)^{1/3}(\lambda - 1)\right], \tag{5.18}$$

where μ_α is the shear modulus of $\overset{(\alpha)}{s}$ in isolation.

The above description is only complete when the factors $\overset{(\alpha)}{n}$ are prescribed for each $\overset{(\alpha)}{s}$. These are the constitutive functions for the composite, specifically describing the interaction. In accordance with the concept of interaction only through dilatation, we make the postulate that they depend only on the current partial Jacobians (or densities):

$$\overset{(\alpha)}{n} = \overset{(\alpha)}{n}\left(\overset{(\beta)}{J}\right) \quad (\alpha,\ \beta = 1,\ 2) \tag{5.19}$$

To discuss the determination of the $\overset{(\alpha)}{n}\left(\overset{(\beta)}{J}\right)$ for a binary mixture, it is convenient to introduce n as follows:

$$\overset{(1)}{n}\left(\overset{(1)}{J},\ \overset{(2)}{J}\right) = n, \qquad \overset{(2)}{n} = 1 - n \tag{5.20}$$

The mixture pressure $p = P(J)$ is given by

$$P(J) = n\, P_1\left(\frac{n}{n_0}\ \overset{(1)}{J}\right) + (1-n)\, P_2\left(\frac{1-n}{1-n_0}\ \overset{(2)}{J}\right) \tag{5.21}$$

where

$$J = \frac{\overset{(1)}{\rho}_0 + \overset{(2)}{\rho}_0}{\overset{(1)}{\rho} + \overset{(2)}{\rho}} = \frac{\overset{(1)}{\rho}_0 + \overset{(2)}{\rho}_0}{\overset{(1)}{\rho}_0 / \overset{(1)}{J} + \overset{(2)}{\rho}_0 / \overset{(2)}{J}} \tag{5.22}$$

Thus, given the pressure-dilatation response relation for the mixture, $p = P(J)$, and those of its constituents, $P_1(J)$, $P_2(J)$, Eq. (5.21) is an implicit equation for $n\left(\overset{(1)}{J},\ \overset{(2)}{J}\right)$ subject to the initial condition $n(1,\ 1) = n_0$.

In order to complete the description of the mechanical model, it is also necessary to specify a constitutive relation for the diffusive interaction term $\rho_0 \eta$ that occurs in the momentum equation (see Section 2.2). We will here assume that the diffusive force $\rho_0 \eta$ depends on the two velocity fields and partial densities. In particular, we will adopt the form

$$\rho_0 \eta = \rho_0 d(w-v) \tag{5.23}$$

where d is a constant with the dimension of the reciprocal of time. Note that Eq. (5.23) is related to Darcy's law (see, e.g., Ishihara[30] and Section 2.5.2.) The significance of this term depends on the relative velocity (w-v), and the stress gradient. As d increases, we would expect the relative velocity to decrease (an opposing force). Negligible (or small) relative velocity which may arise with larger values of d would imply that both constituents have approximately the same velocity field, and then the assumption of a single velocity field and single constituent described by the total stress-deformation law may be applicable.

5.2.2 Non-Dimensional Formulation

The system of conservation equations* can be more simply expressed in terms of (X, t) where X is a material coordinate for the first material and by eliminating partial densities $\overset{(1)}{\rho}, \overset{(2)}{\rho}$ in favor of the Jacobians of deformations

$$\lambda = \overset{(1)}{J} = \overset{(1)}{\rho_0} / \overset{(1)}{\rho}, \qquad \lambda = \overset{(2)}{J} = \overset{(2)}{\rho_0} / \overset{(2)}{\rho} \tag{5.24}$$

*See Chapter II.

Thus for any function $f(x,t) = \tilde{f}(X,t)$, one has

$$\frac{\partial f}{\partial x} = \frac{1}{\lambda}\frac{\partial \tilde{f}}{\partial X}, \quad \frac{\overset{(1)}{D} f}{Dt} = \frac{\partial \tilde{f}}{\partial t}$$

$$\frac{\overset{(2)}{D} f}{Dt} = \frac{\partial \tilde{f}}{\partial t} + \frac{w-v}{\lambda}\frac{\partial \tilde{f}}{\partial X} \tag{5.25}$$

We now define L to be some characteristic length. A convenient measure for a typical wave speed is an acoustic wave speed (S_0) in material $\overset{(1)}{s}$ based on the initial partial density $\overset{(1)}{\rho}_0$:

$$\overset{(1)}{\rho}_0 S_0^2 = \left.\frac{d P_1(\bar{\mu})}{d\bar{\mu}}\right|_{\bar{\mu}=0} \tag{5.26}$$

where $\bar{\mu} = (1/J) - 1$.

We also introduce the following non-dimensional variables:

$$\left.\begin{aligned} Z &= X/L & \tau &= S_0 t/L \\ \bar{v} &= v/S_0 & \bar{w} &= w/S_0 \\ \bar{\sigma} &= \sigma/\overset{(1)}{\rho}_0 S_0^2 & \bar{d} &= Ld/S_0 \\ C_0 &= \overset{(1)}{\rho}_0/\rho_0 & 1 - C_0 &= \overset{(2)}{\rho}_0/\rho_0 \end{aligned}\right\} \tag{5.27}$$

Substituting from Eqs. (5.24) through (5.27) into mass and momentum conservation equations (Chapter II), we obtain the

desired non-dimensional system of conservation equations:

$$\frac{\partial\lambda}{\partial\tau} = \frac{\partial\bar{v}}{\partial Z} \tag{5.28}$$

$$\frac{\partial\gamma}{\partial\tau} + \frac{\bar{w}-\bar{v}}{\lambda}\frac{\partial\gamma}{\partial Z} = \frac{\gamma}{\lambda}\frac{\partial\bar{w}}{\partial Z} \tag{5.29}$$

$$\frac{\partial\bar{v}}{\partial\tau} = \frac{\lambda\bar{d}}{C_0}(\bar{w}-\bar{v}) + \frac{\partial\overset{(1)}{\bar{\sigma}}_x}{\partial Z} + \frac{\overset{(2)}{\bar{\sigma}}_x}{\underset{n}{(2)}}\frac{\partial\overset{(2)}{n}}{\partial Z} \tag{5.30}$$

$$\frac{\partial\bar{w}}{\partial\tau} + \frac{\bar{w}-\bar{v}}{\lambda}\frac{\partial\bar{w}}{\partial Z} = \frac{-\gamma\bar{d}}{1-C_0}(\bar{w}-\bar{v}) + \frac{C_0}{1-C_0}\frac{\gamma}{\lambda}\left(\frac{\partial\overset{(2)}{\bar{\sigma}}_x}{\partial Z} - \frac{\overset{(2)}{\bar{\sigma}}_x}{\underset{n}{(2)}}\frac{\partial\overset{(2)}{n}}{\partial Z}\right) \tag{5.31}$$

This governing system is completed by adjoining the constitutive laws:

$\overset{(1)}{s}$ (Rock Matrix):

<u>Plastic Regime</u>

$$s\left(\overset{(1)}{\bar{\sigma}}_y - \overset{(1)}{\bar{\sigma}}_x\right) = n\,Y_1 / \overset{(1)}{\rho}_0\,S_0^2 \tag{5.32}$$

$$\frac{1}{3}\left(\overset{(1)}{\bar{\sigma}}_x + 2\,\overset{(1)}{\bar{\sigma}}_y\right) = -\,n\,P_1\!\left(\frac{n}{n_0}\lambda\right) / \overset{(1)}{\rho}_0 S_0^2 \tag{5.33}$$

where $Y_1/2$ is the maximum shear strengh the isolated poreless rock can withstand.

Elastic Regime

Equation (5.32) and

$$d\left(\frac{\overset{(1)}{\bar{\sigma}}_x - \overset{(1)}{\bar{\sigma}}_y}{n}\right) = \frac{2\mu_1}{\overset{(1)}{\rho}_0 \; S_0^2} \; d\left[\left(\frac{n}{n_0}\right)^{1/3} (\lambda - 1)\right] \tag{5.34}$$

where μ_1 is the shear modulus of the isolated poreless rock.

$\overset{(2)}{s}$ (Fluid):

$$\overset{(2)}{\bar{\sigma}}_x = - (1-n) \; P_2\left(\frac{1-n}{1-n_0} \, \gamma\right) \Big/ \overset{(1)}{\rho}_0 S_0^2 \tag{5.35}$$

where $n(\lambda, \gamma)$ is given by Eq. (5.21)

In order to formulate the initial and boundary conditions, we consider the half space $Z > 0$ initially at rest. Thus,

$$\left.\begin{aligned} \bar{v} &= \bar{w} = 0 \\ \lambda &= \gamma = 1 \end{aligned}\right\} \text{ at } \quad \tau = 0, \; Z > 0 \tag{5.36}$$

The motion of the material plane $Z = 0$ is prescribed for $\tau > 0$ as if both constituents move together

$$\bar{v} = \bar{w} = \bar{V}(\tau) \quad \text{on} \quad Z = 0, \; \tau > 0 \tag{5.37}$$

5.3 SATURATED WET TUFF CALCULATIONS

The experimental data required to evaluate the various interaction functions are discussed in Section 5.3.1. In Section 5.3.2, we present a parametric study for saturated wet tuff, and compare TINC calculations with experimental results.

5.3.1 Material Parameter Assumptions

To evaluate $n\left(\overset{(1)}{J}, \overset{(2)}{J}\right)$ from Eq. (5.21), we need the pressure-dilatation response for the mixture, P(J), and those of its components, $P_1(J)$ and $P_2(J)$. The mechanical pressure-dilatation responses of a representative NTS tuff matrix material $\overset{(1)}{s}$ (poreless $\overline{\text{NTS}}$ tuff) and water $\overset{(2)}{s}$ have been presented in 3SR-267. The poreless $\overline{\text{NTS}}$ behavior is characterized by the unloading p-V data from a state in which all the voids have been collapsed. Least squares polynomial fits for these two constituents of saturated wet tuff are

$$\begin{aligned} P_1(J) &= \overset{(1)}{A}\,\bar{\mu} + \overset{(1)}{B}\,\bar{\mu}^2 + \overset{(1)}{F}\,\bar{\mu}^3, \\ P_2(J) &= \overset{(2)}{A}\,\bar{\mu} + \overset{(2)}{B}\,\bar{\mu}^2 + \overset{(2)}{F}\,\bar{\mu}^3 \end{aligned} \qquad (5.38)$$

where $\bar{\mu} = (1/J) - 1$. The parameters $\overset{(1)}{A}, \overset{(1)}{B}, \ldots, \overset{(2)}{F}$ are listed in Table 2.1 together with the range of validity of the fit.

In order to use Eq. (5.21) to evaluate n, we also require the mixture response P(J). Unfortunately, the available data for P(J) and $P_1(J)$ are not sufficiently accurate to enable the use of the implicit Eq. (5.21).

Since wet tuff has a very low compressive strength ($Y_1 < 1$ kbar) it is permissible to require at least as a first approximation that the effective pressure in both constituents be the same.† Therefore, we have

$$P_1\left(\frac{n}{n_0}\,{}^{(1)}J\right) = P_2\left(\frac{1-n}{1-n_0}\,{}^{(2)}J\right) \tag{5.39}$$

Thus, given $P_1(J)$ and $P_2(J)$, Eq. (5.39) is an implicit equation for $n\left({}^{(1)}J, {}^{(2)}J\right)$. Note that the water mass fraction, M_W, is related to n_0 through the equation

$$\frac{1}{n_0} = 1 + \frac{M_W}{1 - M_W}\;{}^{(1)}\rho_0^e / {}^{(2)}\rho_0^e \tag{5.40}$$

---

†Under isothermal (25°C) hydrostatic loading isolated water freezes at 9.8 kbar and subsequently undergoes a structural transition (Ice VI to Ice VII) at 22.3 kbar. These pressure values appear to nearly coincide with the p-V discontinuities in the saturated tuff data reported by Stephens, et al. [23]. From this, it can be concluded that the effective pressure in the water/ice component is essentially equal to that of the composite which implies that the assumption of balance between the effective pressures of the water/ice and the tuff is justified.

Tests show that saturated wet tuff has a shear strength of less than 0.5 kbar and this may be the reason that the pressure balance is attained. For a stronger rock, e.g., granite, one would not expect this to be true. In fact a recent report by La Mori [31] presents data on saturated Cedar City tonalite which shows the p-V discontinuity corresponding to the Ice VI-VII transition to occur at about 30 kbar rather than 22.3 kbar in a jacketed hydrostatic test. This means that the effective pressure in the rock is considerably higher than in the water/rock component. This observation supports the connected pore postulate (discussed in Chapter IV) for the case of granite.

We also give in Table 2.1 equation-of-state coefficients for a polynomial fit, of the form of Eq. (5.38), for an homogenized model for saturated wet tuff constructed by assuming pressure equilibrium (and no relative motion) between the two constituents. Hugoniot predictions from this PEQ model will be used to compare with TINC calculations in which diffusion occurs.

From data given by Davies in Ref. 32 for slow diffusion through tuff, d takes values in the range 10^6 - 10^9 sec^{-1}.

5.3.2 Stress Pulse Propagation

The governing system of equations (5.28) through (5.31) together with the constitutive relations are solved by the two-step Lax-Wendroff (see Richtmyer and Morton [33]) finite difference procedure. This scheme has second order accuracy $[O(\Delta\tau)^2]$. The provisional values are first calculated at the centers of the rectangular meshes (j + 1/2, n + 1/2) of the (Z-τ) plane. The final values at mesh points (j, n+1) are then calculated from provisional values. The details of the finite difference scheme are given in Appendix E. In order to treat the shocks, it is necessary to introduce some artificial dissipation in the numerical procedure. In addition to a quadratic von-Neumann-Richtmyer type artificial viscosity term, provision has been made for another second order viscosity-type term. To derive an expression for the latter term, we proceed as follows. Given the value of any function f at (j,n) we first calculate its value at (j, n+1) by the two-step Lax-Wendroff procedure. Finally, given f_j^n, f_j^{n-1} and f_j^{n+1}, a new corrected value for f_j^{n+1} is calculated as

$$\tilde{f}_j^{n+1} = f_j^n + \frac{1}{2}\left(f_j^{n+1} - f_j^{n-1}\right) + \frac{\omega}{2}\left(f_j^{n+1} - 2f_j^n + f_j^{n-1}\right) \qquad (5.41)$$

where ω is a constant (> 1). Note that if ω equals 1, then $\tilde{f}_j^{n+1}$ is the same as f_j^{n+1}. As long as $\omega \neq 1$, $\tilde{f}_j^{n+1}$ is different from f_j^{n+1} by a term of order $(\Delta\tau)^2$. For subsequent calculations $\tilde{f}_j^{n+1}$ is taken as the value of f at (j, n+1). Actual experience with the numerical scheme outlined above has shown that for weak shocks, Eq. (5.41) provides sufficient smoothing of the shock front and one can dispense with the artificial viscosity term. However, for stronger shocks, it is necessary to employ both the quadratic artificial viscosity term and Eq. (5.41) to eliminate the over-shoot at the shock front. The finite difference scheme has been incorporated into a one-dimensional computer code POROUS.

In order to understand the effects of various material constants in the TINC model, parameter studies were conducted for a wave propagating in a saturated wet tuff medium. To highlight the effects of the diffusive resistance d, first calculations were made ignoring the material strength, i.e., both tuff and water were treated as perfect fluids. In Fig. 5.1, we present pressure profiles in the composite for two values of the diffusion parameter d (10^6 sec^{-1} and 10^7 sec^{-1}). For these calculations, the initial input pulse was selected to be a step function in time. The following input parameters were prescribed in the POROUS runs:

$$v(0, t) = w(0, t) = 7.786\ 10^4 \text{ cm/sec}, \quad t \geq 0$$

$$\Delta\tau = 0.002$$

$$\Delta Z = 0.006$$

$$L = 1 \text{ cm}$$

The particle velocities for water and tuff are shown in Figs. 5.2 and 5.3. For sake of comparison, we also indicate in Figs. 5.1 through 5.3 the solution obtained by utilizing

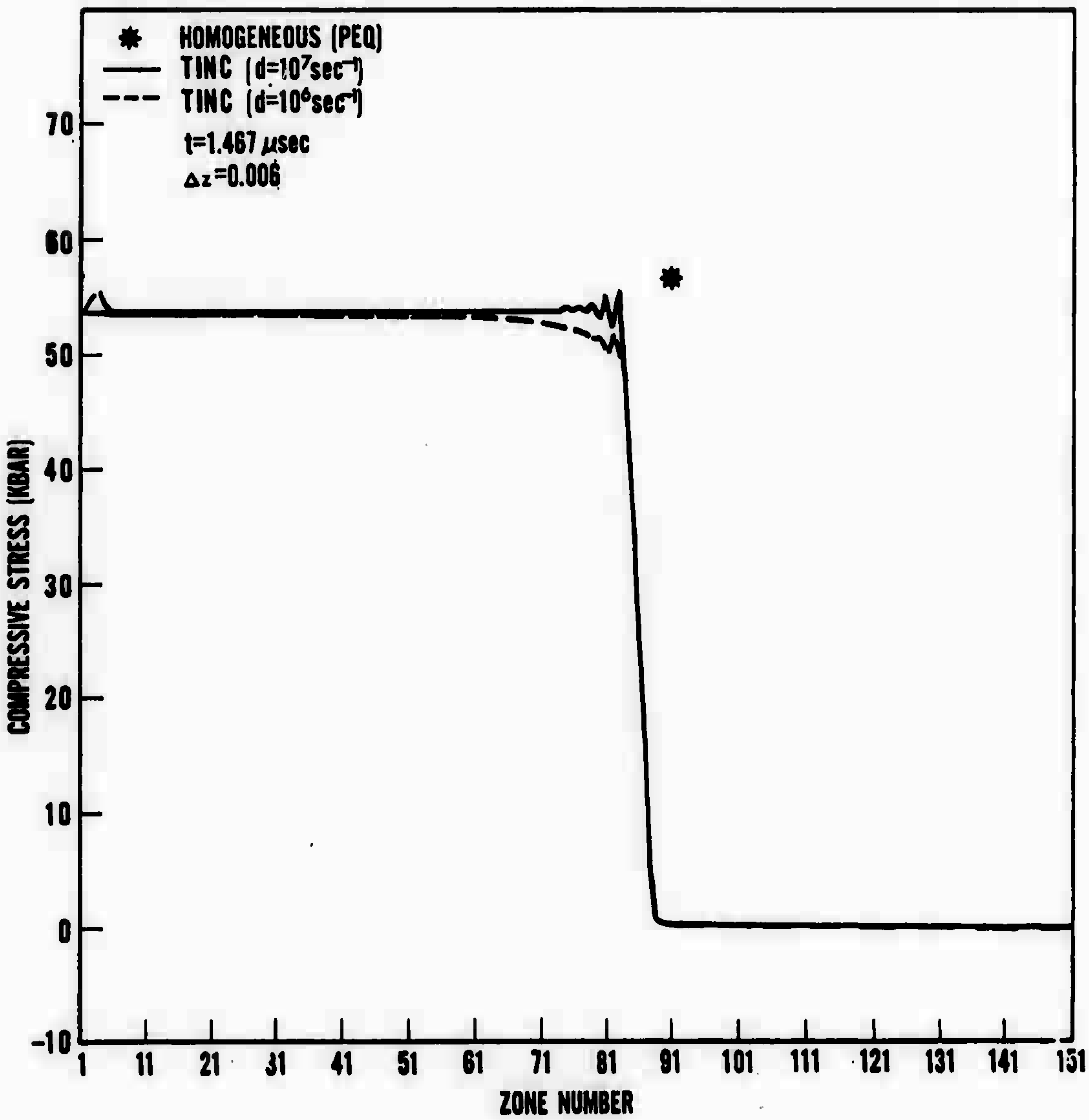

Fig. 5.1--Comparison of pressure profiles [$d = 10^6\ sec^{-1}$, $d = 10^7\ sec^{-1}$, homogeneous model] resulting from velocity step loading of $v(0,t) = 7.786 \times 10^4$ cm/sec.

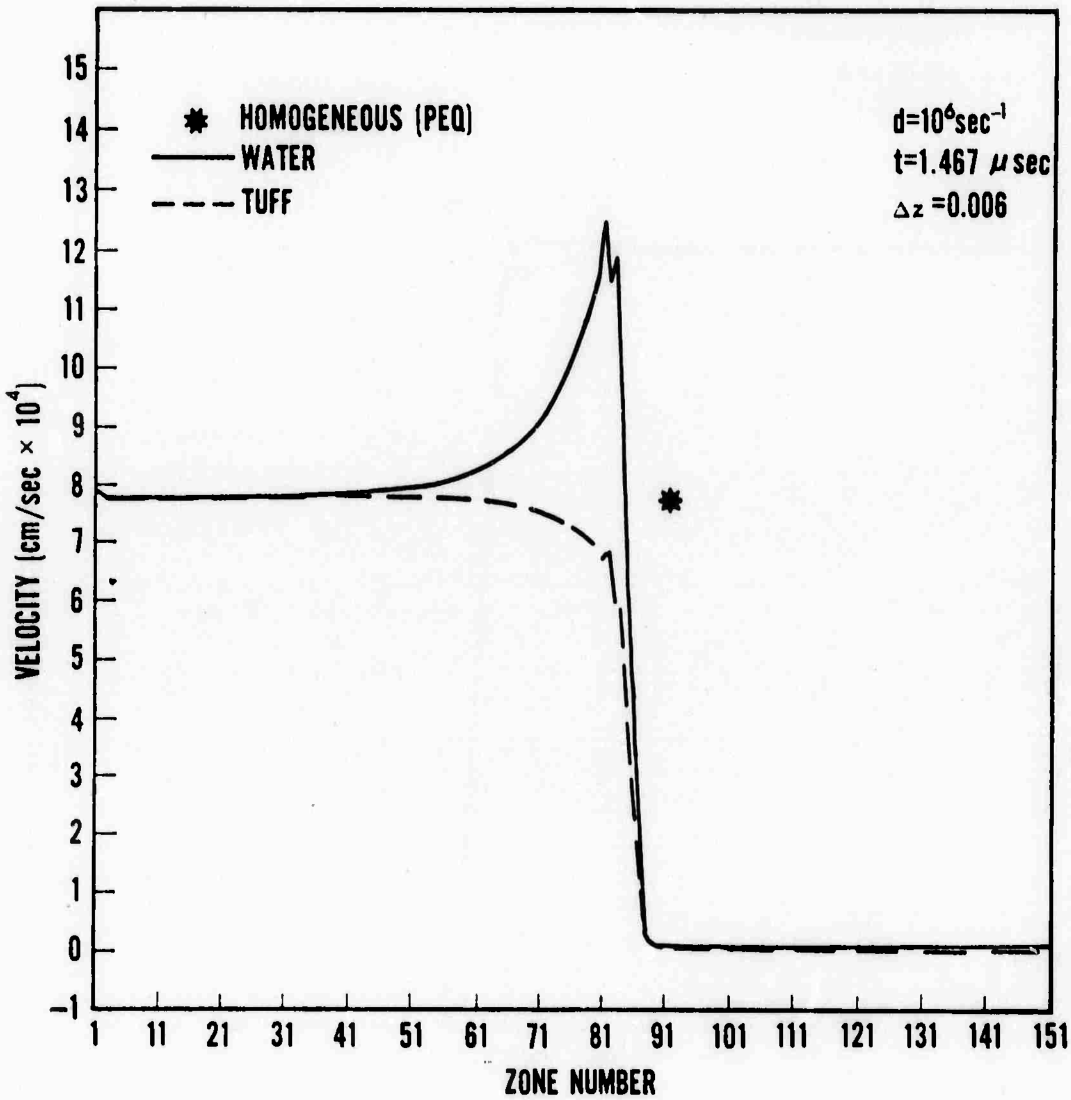

Fig. 5.2--Velocity profiles for the water and NTS poreless tuff components with $d = 10^6$ sec^{-1} and $v(0,t) = 7.786 \times 10^4$ cm/sec.

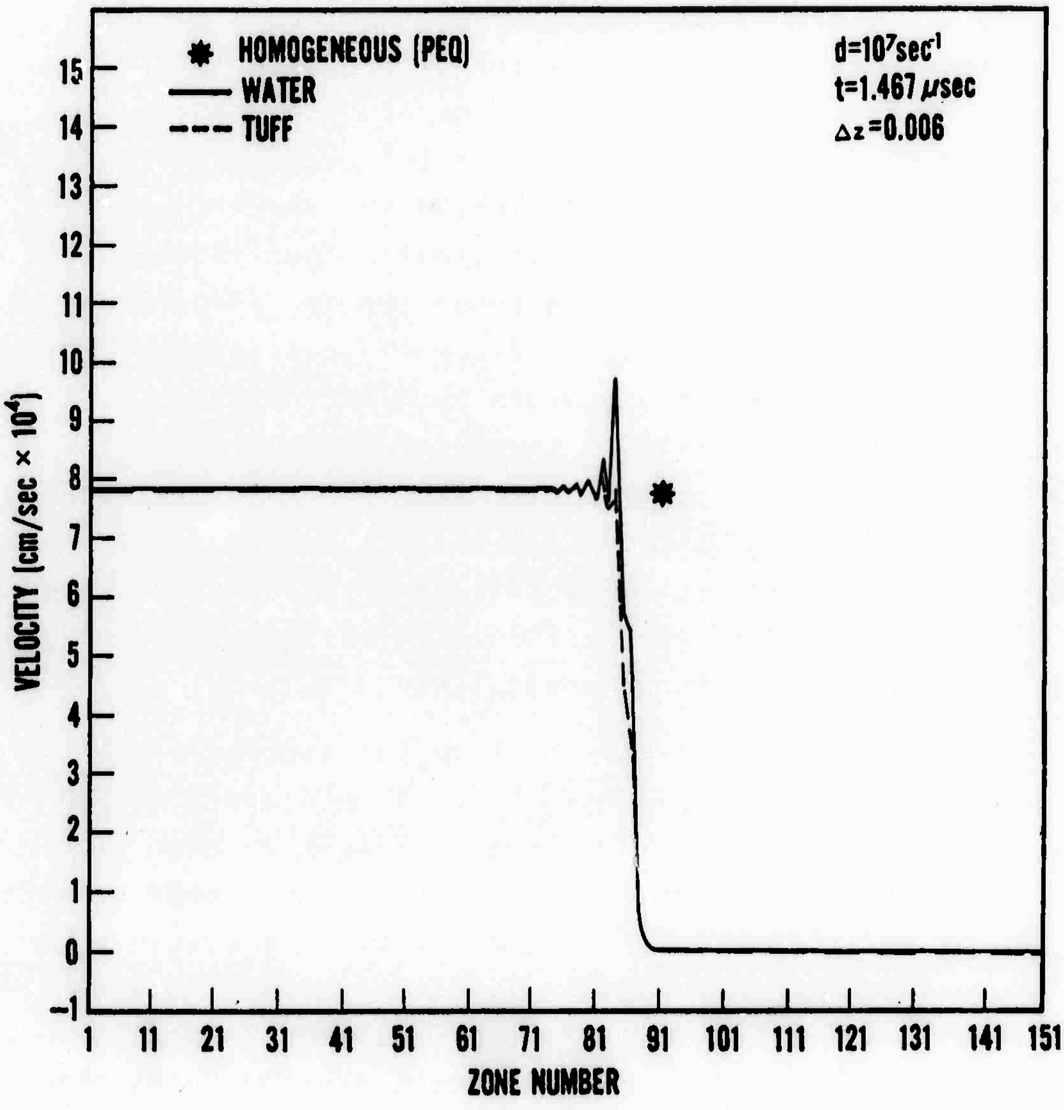

Fig. 5.3--Velocity profiles for the water and $\overline{\text{NTS}}$ poreless tuff components with $d = 10^7\ \text{sec}^{-1}$ and $v(0,t) = 7.786 \times 10^4$ cm/sec.

the homogenized model. It appears from Fig. 5.1 that an increase in the Darcy coefficient d, Eq. (5.23), leads to an increase in composite pressure at a specified distance behind the shock front. The homogenized model yields composite pressure (and shock velocity) which is greater than that calculated by the TINC model. For the smaller value of diffusive resistance ($d = 10^6$ sec^{-1}), the particle velocity of water immediately behind the shock front (Fig. 5.1) is predicted by TINC to be much greater than that of tuff. However, far behind the shock front the two particle velocities become the same due to diffusive resistance. Comparison of Figs. 5.2 and 5.3 reveals that increasing the value of the diffusive resistance results in a much smaller difference in the particle velocities. For the present version of the POROUS code, $d = 10^7$ sec^{-1} is for all practical purposes the upper limit for diffusive resistance for which a stable calculation can be run. Increasing d beyond these values leads to numerical instability.

The POROUS runs show that in the times (∿1 μsec), and distances (∿1 cm), considered here, only a quasi-steady state is achieved under the assumption of simple Darcian flow. Although the shock appears to move with a constant velocity, the unsteady region (region with different particle velocities) keeps on increasing. The steady state is attained only asymptotically. With a more realistic constitutive assumption for the TINC diffusive interaction term, the steady state may or may not be attained in a short time. In Section 5.5 a discussion is presented of possible non-Darcian interaction terms that are being considered at present.

In Section 2.3, Hugoniot relations for a binary mixture were presented within the TINC framework. In deriving those relations it was implicitly assumed that a steady-state situation was attained such that for a coordinate system

moving at the shock velocity it was possible to consider a control volume of fixed width within which the flow was invariant. In that case the Hugoniot pressure is unchanged by the assumed interaction force, provided it is of the form that permits the realization of the assumed steady-state (see Table 2.3). The significance of the POROUS runs presented in Figs. 5.1 through 5.3 is that a simple Darcy diffusive interaction force has not produced a steady-state since the "control volume" increases in width as the pulse propagates. Whether or not this is a physically realistic effect remains to be answered during the next contract period.

In order to further illustrate the differences between the TINC and homogenized models, we compare corresponding pressure-pulse profiles for the two models in Fig. 5.4. The following input parameters were assumed for these POROUS code pulse propagation calculations:

$$v(0,t) = w(0,t) = 7.786 \times 10^3 \sin\left(\pi t/t_0\right) \text{ cm/sec} \qquad t \leq 0.97\, t_0$$

$$= 7.786 \times 10^3 \sin(0.97\pi) \text{ cm/sec} \qquad t \geq 0.97\, t_0$$

$$t_0 = 0.5 \times 10^{-6} \text{ sec}$$

$$d = 10^6 \text{ sec}^{-1} \text{ (TINC only)}$$

$$\Delta Z = 0.004,\ L = 1 \text{ cm.}$$

Note that the peak amplitude and the wave velocity predicted by the TINC model is smaller than that given by the homogenized equation of state. This result is, of course, not unexpected in view of the step pulse calculations discussed in the preceeding.

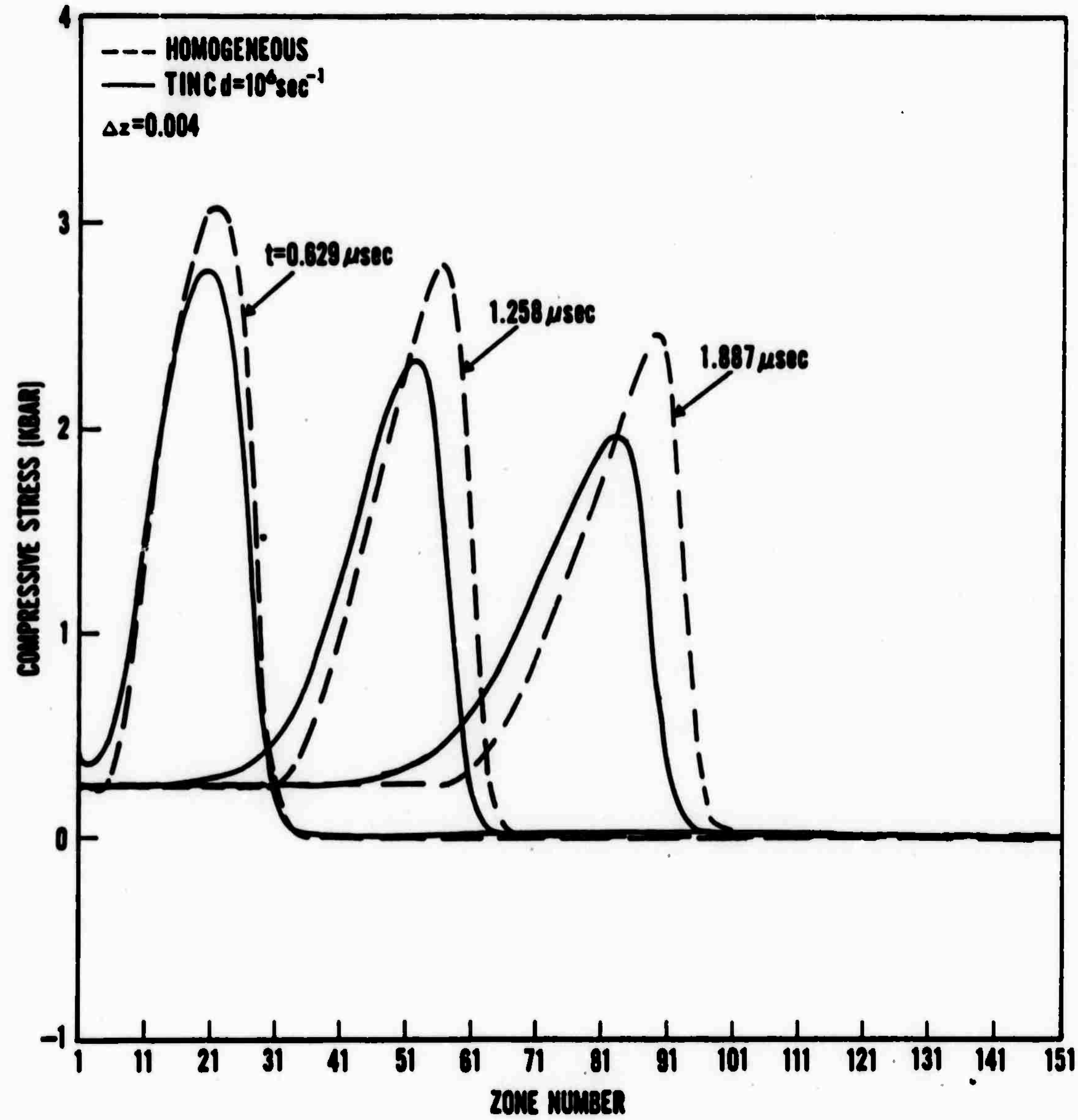

Fig. 5.4--Comparison of pressure-pulse profiles [d = 10^6 sec^{-1}, homogeneous model] with no strength terms and a smooth input pulse.

To test the effects of the inclusion of material strength, a calculation was run for the following input parameters in the POROUS code:

$$d = 10^6 \text{ sec}^{-1}$$

$$Y_1 = 1 \text{ kbar (yield stress for poreless tuff)}$$

$$\mu_1 = 51.49 \text{ kbar (shear modulus for poreless tuff)}$$

The same smooth half-sine input pulse and zoning were used for the POROUS runs described above.

In Fig. 5.5 we compare the stress-pulse profiles for this case to those calculated when no strength terms were included. An elastic precursor may be seen. The pulse attenuates much more rapidly than is the case with no strength terms. This is the case since elastic-plastic unloding waves move with a higher velocity than the hydrodynamic release waves. In addition, the elastic precursor produced by the inclusion of strength terms results in a much larger spread of the wave. We should, however, like to remark that this calculation with strength terms has only a qualitative significance as the assumption of pressure equilibrium between the water and the NTS poreless tuff, Eq. (5.39), is open to question at this low stress level.

In Fig. 5.6 we compare the stress-pulse profiles calculated with POROUS for the TINC model ($d = 10^6$ sec^{-1}, including strength terms) with those calculated for the homogenized model ($Y = n_0 Y_1$, $\mu = n_0 \mu_1$). The homogenized model, as in the case with no strength terms, predicts higher peak amplitude and wave velocity than the TINC model.

In Fig. 5.7 we show the saturated wet tuff Hugoniot data of Rosenberg et al[5] for two initial composite densities, viz ρ_0 = 1.95 g/cc and 2.05 g/cc. Assuming $\rho_0^{(1)e}$ = 2.4 g/cc, these correspond to water mass fractions of 0.165 and 0.122,

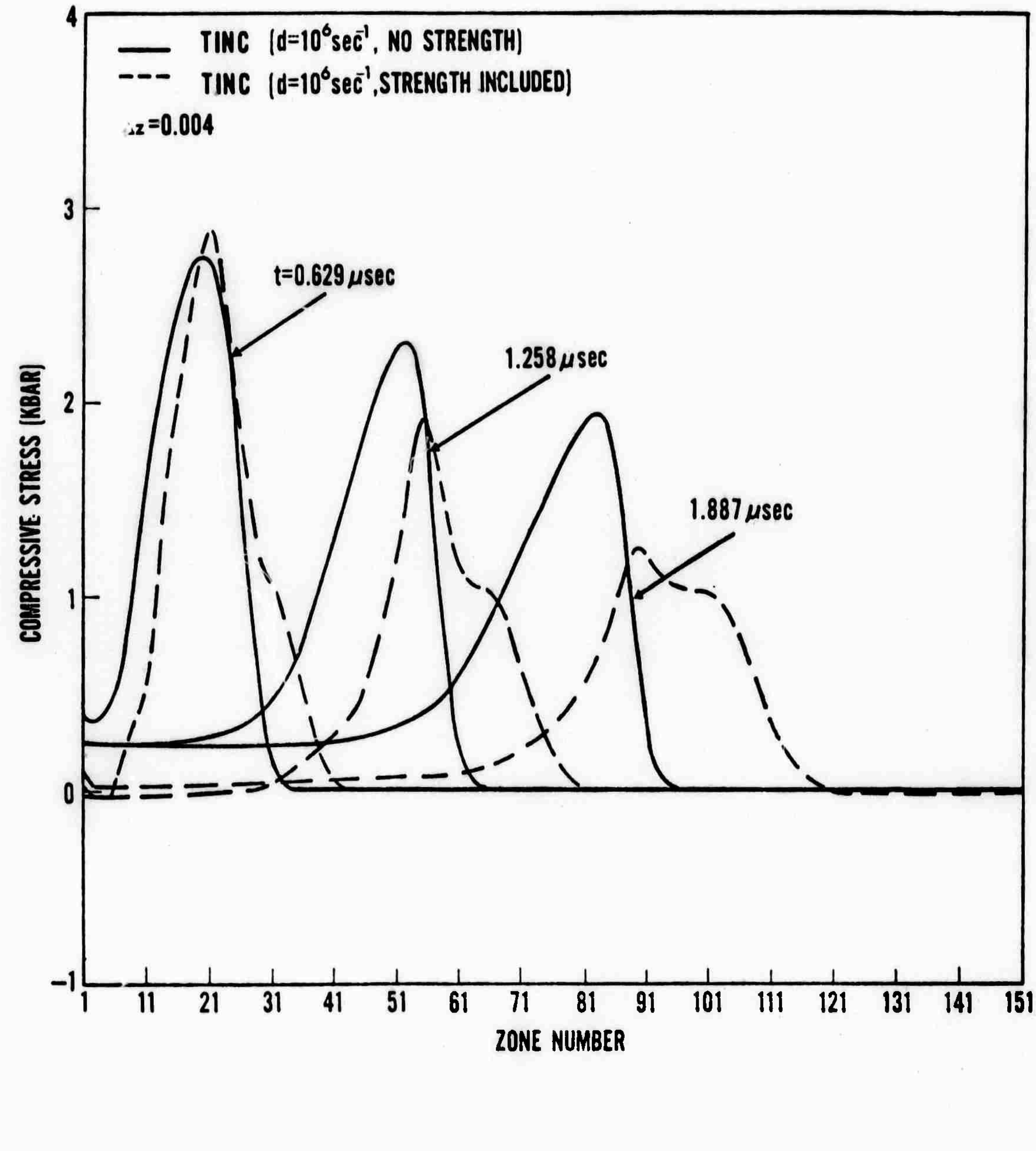

Fig. 5.5--Effect of strength terms on the stress-pulse profiles calculated with the POROUS code using the TINC model.

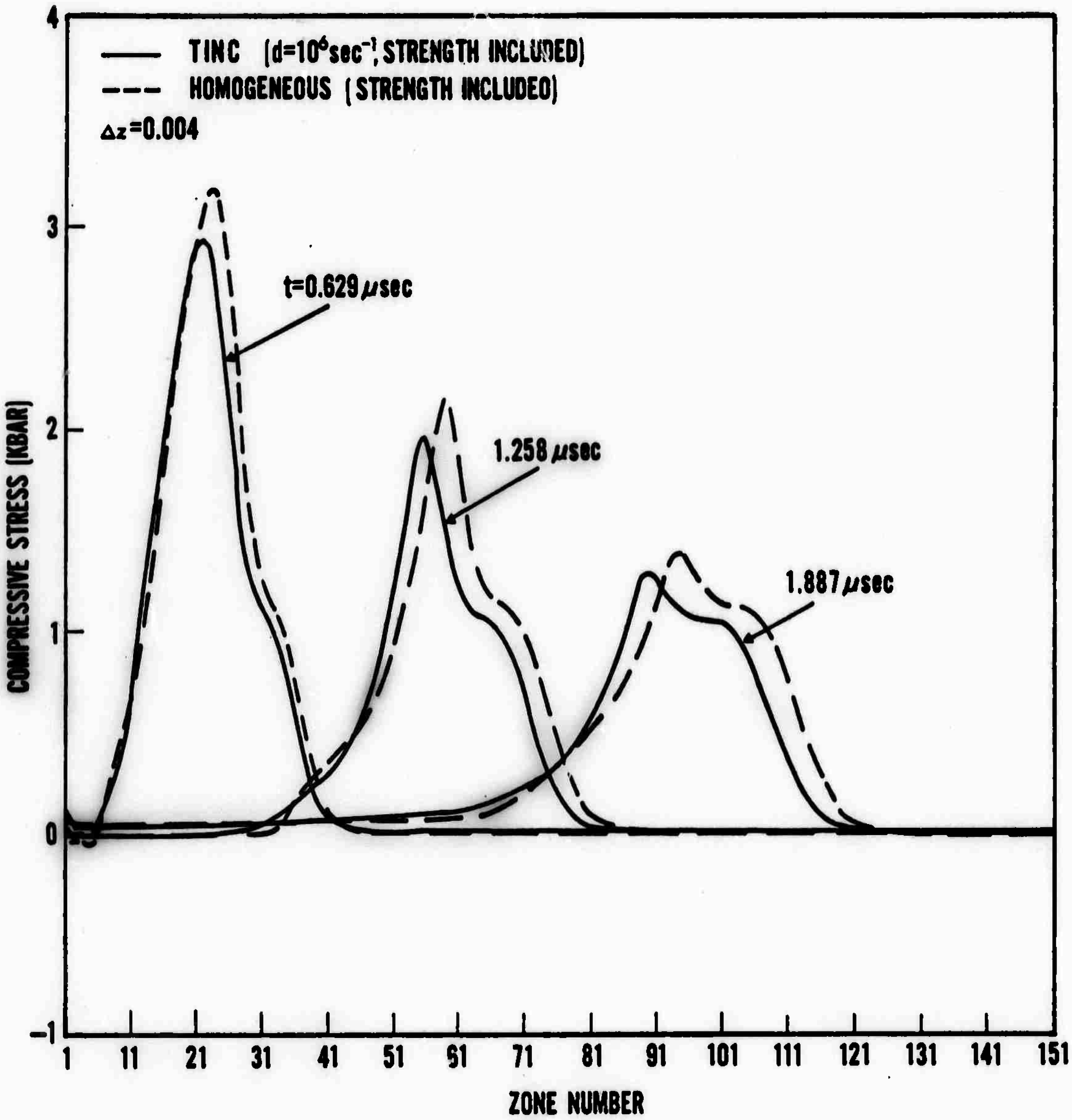

Fig. 5.6--Comparison of the stress-pulse profiles calculated with the POROUS code using the homogenized PEQ and TINC models.

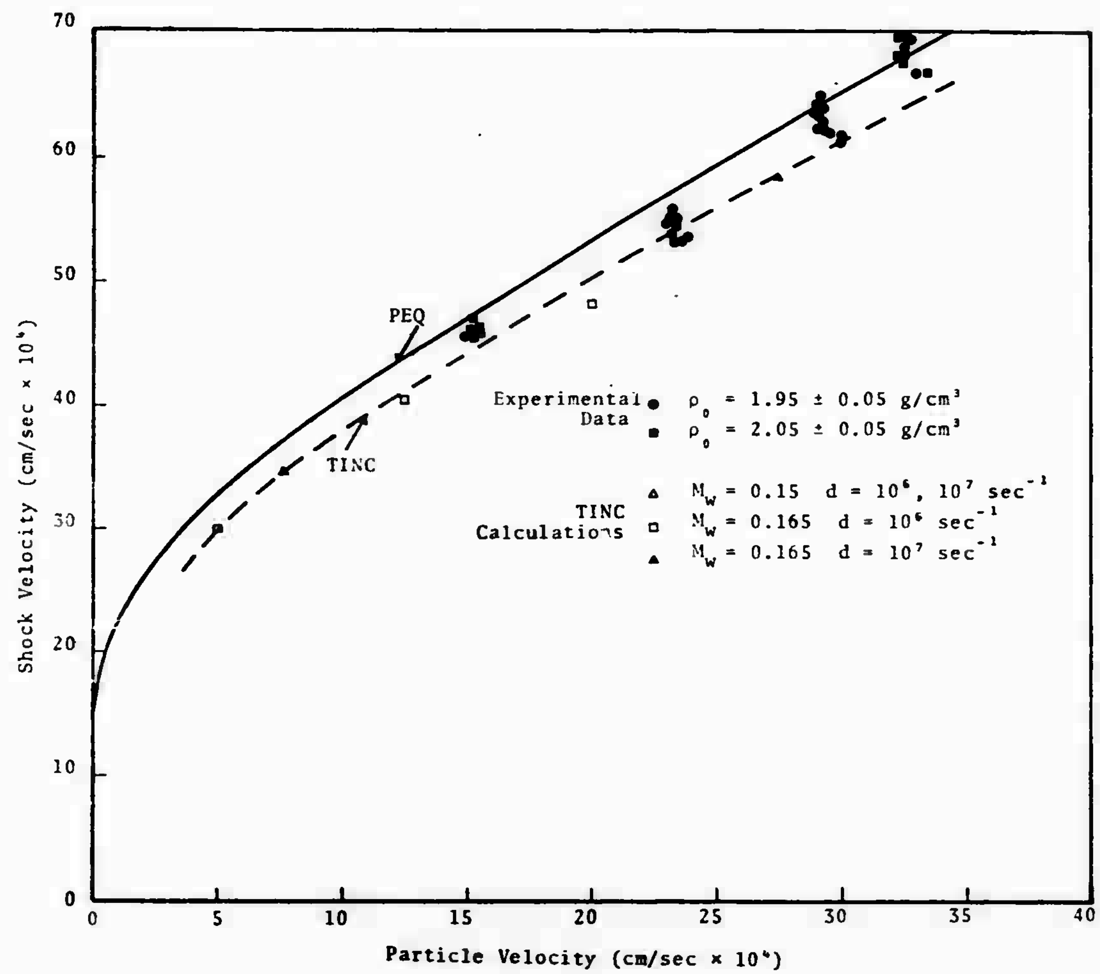

Fig. 5.7--Comparison of experimental data for saturated wet tuff with PEQ and TINC predictions. The matrix material was treated as $\overline{\text{NTS}}$ poreless tuff in the calculations.

respectively. For comparison purposes, the Hugoniot predictions obtained from the PEQ and TINC models, based on the NTS poreless tuff equation of state for the tuff components, are also given in Fig. 5.7. The PEQ predictions in u-U plane for the two water mass fractions are nearly identical. POROUS runs were made to determine the TINC predictions for two values of the diffusivity parameter, d(= 10^6 and 10^7 sec^{-1}). At low pressures, the shock velocity does not significantly depend upon the choice of d. As can be seen from Fig. 5.7, this is no longer true at higher pressures. This leads one to consider whether the diffusivity parameter is pressure dependent.* Returning to Fig. 5.7, we observe that the PEQ curve generally lies above the experimental data whereas the TINC curve lies below it. By a proper selection of the diffusivity parameter, d, TINC results may be made to correspond more closely to the experimental data. The present TINC calculations using a simple Darcy law suggest that a steady state is not attained in the laboratory experiments [t $\sim$ 1 μsec, x $\sim$ 1 cm]. This inference must, however, be regarded as tentative pending further work on the development of non-Darcian constitutive relations for the diffusive interaction term, $\rho_0 \eta$.

*See Section 5.5.2.

5.4 POROUS DRY TUFF PULSE RUNS

The POROUS code, originally developed for a liquid saturated porous material, may also be used for calculations for a single material by appropriately specifying the input parameters. The code has been modified to include the irreversible crushup model for dry tuff developed in Chapter IV. Provision has been also made for applying a pressure boundary condition at $(j = 1\frac{1}{2},\ n + \frac{1}{2})$. Pressure at the boundary is specified through the relation

$$n\, P_1\left(\frac{n}{n_0}\,\lambda\right) = p(t), \tag{5.42}$$

where $p(t)$ is an arbitrary function of time. The Jacobian, $\lambda_{1+\frac{1}{2}}^{n+\frac{1}{2}}$ is determined by solving the implicit Eq. (5.42) through an iterative procedure. The velocity, $v_{1+\frac{1}{2}}^{n+\frac{1}{2}}$ is then obtained from the regular scheme at $(j+\frac{1}{2},\ n+\frac{1}{2})$.

In Fig. 5.8, we present pressure-time profiles in the porous medium. The initial input pulse was selected to be a step function in time. The following input parameters were prescribed:

$$p(t) = 5 \text{ kbar} \qquad t \geq 0$$

$$L = 1 \text{ cm} \qquad \Delta Z = 0.004$$

$$n_0 = 0.85$$

Numerical oscillations are observed near the boundary which could not be eliminated by increasing the artificial viscosity. Such oscillations appear to be a characteristic feature of porous material calculations since they appear when using other finite difference schemes.

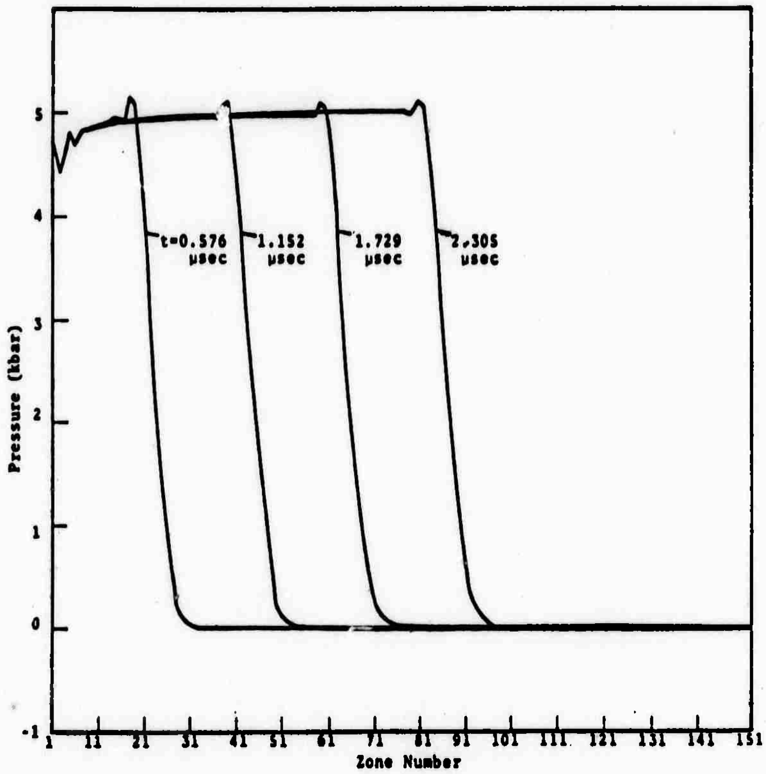

Fig. 5.8--Pressure-time profiles for $\overline{\text{NTS}}$ porous dry tuff (n_0 = 0.85) with step pulse input (ΔZ = 0.004).

To investigate the effect of initial porosity on attenuation and shock speed, calculations were run with the input boundary pressure taken to be a half sine pulse.

$$p(t) = 5 \sin\left(\pi t/t_0\right) \qquad 0 \leq t \leq t_0$$

$$= 0 \qquad t \geq t_0$$

$$t_0 = 0.5\ \mu\text{sec} \qquad \Delta Z = 0.004$$

$$n_0 = 0.85 \text{ and } 0.75$$

The pressure-time profiles are shown in Figs. 5.9 and 5.10. Increasing the porosity results in faster attenuation and slower wave speed.

Presently, work is in progress on encoding the $\overline{\text{NTS}}$ porous wet tuff model into the POROUS code.

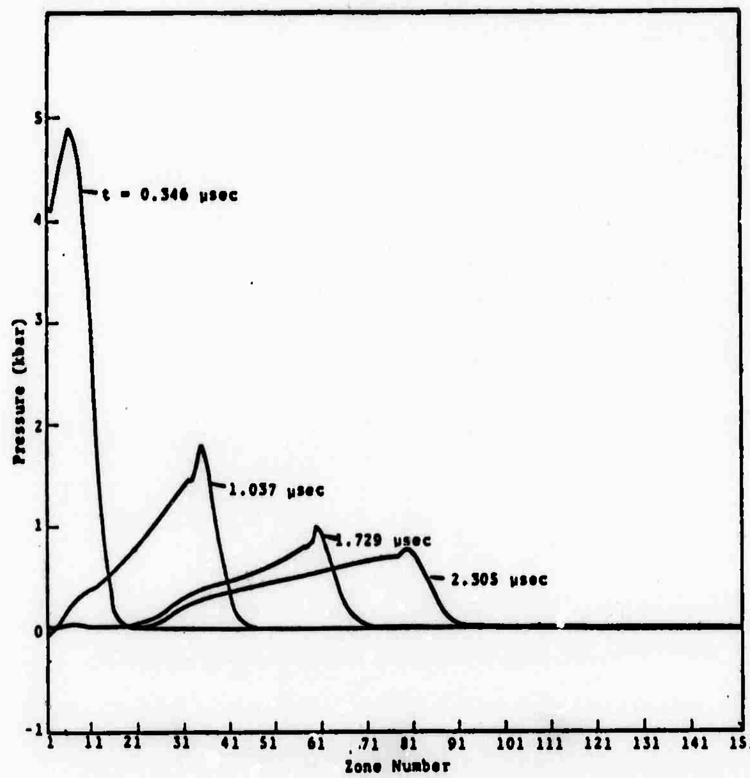

Fig. 5.9--Stress pulse propagation through $\overline{NTS}$ porous dry tuff with $n_0 = 0.85$ ($\Delta Z = 0.004$).

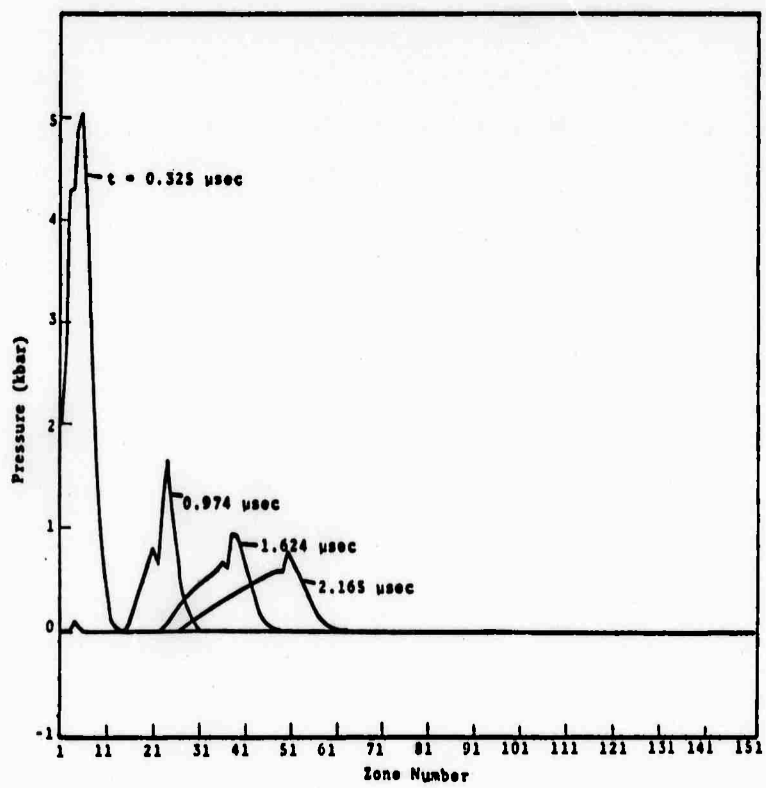

Fig. 5.10--Stress pulse propagation through $\overline{NTS}$ porous dry tuff with $n_0 = 0.075$ ($\Delta Z = 0.004$).

5.5 SIMPLE MODIFICATIONS OF BASIC TINC MODEL

In the mechanical TINC framework reviewed in Section 5.2, we considered an ideally elastic-plastic liquid saturated porous solid as a basis for modeling geologic materials. Simple modifications of the TINC framework that are easy to make and greatly improve the model include (a) the effect of confining and pore pressures, (b) non-Darcian flow. We will discuss these effects very briefly in the following subsections.

5.5.1 Effect of Confining and Pore Pressures

Tests have repeatedly shown that the compressive strength of rocks displays a strong dependence on the confining pressure. (See, e.g., Robinson[34] and Byerlee.[35]) An increase in the confining pressure increases the stress required to overcome the friction resisting the sliding of one block of rock on another.

The Coulomb criterion states that shear fracture takes place across a plane on which the shear stress (τ) first becomes equal to a constant (τ_0) plus a constant (μ_f) times the normal stress (σ_n) across the plane (see Jaeger[36]).

$$\tau = \tau_0 + \mu_f \sigma_n \tag{5.43}$$

τ_0 is known as the cohesive shear strength, and μ_f is coefficient of sliding friction. Walsh[37] has presented a theoretical derivation of the Coulomb criterion in terms of planar elliptical cracks distributed through the rock.

Let us consider an element of dry rock subjected to uniaxial compressive strain $\left(\sigma_x, \sigma_y < 0\right)$. The rock will fail by slip along some plane inclined at angle α to the y-axis.

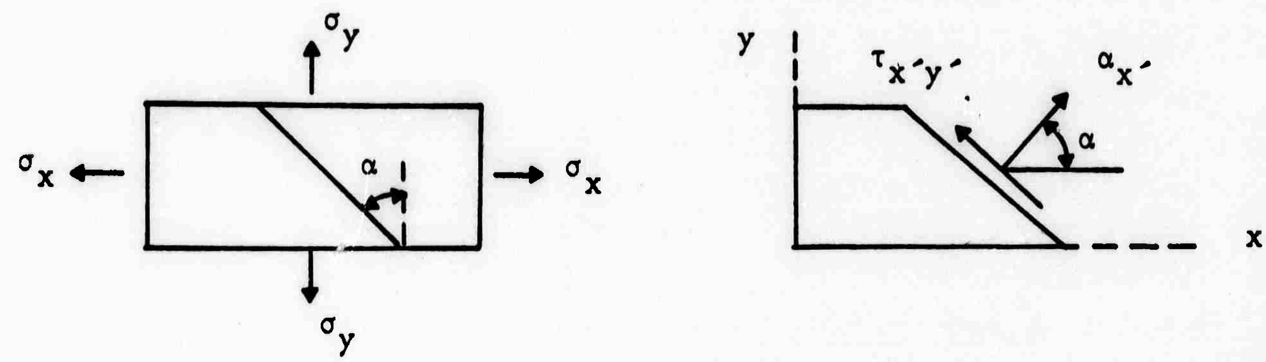

Fig. 5.11--Resolution of stresses on the failure surface.

The shear stress along the plane and normal stress perpendicular to the slip plane are given by

$$\begin{aligned} \tau_{x'y'} &= -\frac{\sigma_x - \sigma_y}{2} \sin 2\alpha \\ \sigma_{x'} &= \frac{\sigma_x + \sigma_y}{2} + \left(\frac{\sigma_x - \sigma_y}{2}\right) \cos 2\alpha \end{aligned} \tag{5.44}$$

Since $\sigma_n \left(= -\sigma_{x'}\right)$ varies with α it follows from (5.43) that the critical shear strength also varies with α. Consequently failure is not in general expected to occur on the plane of maximum shear ($\alpha = 45°$). Triaxial compression tests have indeed demonstrated that the failure surface is often different from 45° (see, e.g., Giardini et al.[38] and Smith et al.[39]). The angle varies with the particular rock $\left(\tau_0, \mu_f\right)$ and with the applied load $\left(\sigma_x, \sigma_y\right)$.

$$\alpha = \alpha\left(\tau_0, \mu_f, \sigma_x, \sigma_y\right) \tag{5.45}$$

After failure the rock is still able to support a shear stress $\mu_f \sigma_n$ along the slip plane.

There is ample evidence that "the law of effective stress" holds for many rocks (see, e.g., Robinson[34]) and Jaeger[36]). This law states that the mechanical behavior of a porous solid depends uniquely on the "effective stress," which is the difference between the total normal compressive stress active on any plane through the rock matrix, and the pressure of a fluid in the pores. The modified Coulomb criterion thus becomes

$$\tau = \tau_0 + \mu_f \left(\sigma_n - \overset{(2)}{p}{}^{e} \right) \tag{5.46}$$

where $\overset{(2)}{p}{}^{e}$ denotes the pore pressure.

If we substitute Eqs. (5.44) into (5.46) we can rewrite the Coulomb criterion as follows:

$$-\left(\sigma_x - \sigma_y\right) = \frac{2\tau_0}{\sin 2\alpha} - \frac{\mu_f}{\sin 2\alpha}\Big[\left(\sigma_x + \sigma_y\right) + \left(\sigma_x - \sigma_y\right)\cos 2\alpha + 2\overset{(2)}{p}{}^{e}\Big] \tag{5.47}$$

Failure will occur on the plane for which this relation is first satisfied. Thereafter the first term on the right is set to zero to determine the maximum stress difference that may be sustained on the failure plane.

It is perhaps useful to point out here some of the differences in the terminology of TINC and the classical geophysics. In TINC the term "effective stress" denotes the stress in the constituent $\overset{(\alpha)}{s}$ referred to its effective cross-sectional area, and the compressive stresses are taken to be negative. In classical geophysics, "effective stress"

refers to the difference between the total compressive stress and the fluid pore pressure, and the compressive stresses are usually taken to be positive. We will use the terminology and conventions of TINC.

We recall from Chapter II that

$$\overset{(2)}{\sigma} = -(1-n)\overset{(2)}{p}{}^{e} = -\overset{(2)}{p} \tag{5.48}$$

and

$$\sigma_x = \overset{(1)}{\sigma}_x + \overset{(2)}{\sigma}_x, \qquad \sigma_y = \overset{(1)}{\sigma}_y + \overset{(2)}{\sigma}_y \tag{5.49}$$

We now wish to replace the Tresca-von Mises yield condition in Eqs. (5.16) and (5.18) with the Coulomb criterion. We first use Eqs. (5.48) and (5.49) to rewrite (5.47) in terms of the partial stress in the tuff:

$$-\left(\overset{(1)}{\sigma}_x - \overset{(1)}{\sigma}_y\right) = \frac{2\tau_0}{\sin 2\alpha} - \frac{\mu_f}{\sin 2\alpha}\left[\left(\overset{(1)}{\sigma}_x + \overset{(1)}{\sigma}_y\right) + 2n\overset{(2)}{p}{}^{e} + \left(\overset{(1)}{\sigma}_x - \overset{(1)}{\sigma}_y\right)\cos 2\alpha\right] \tag{5.50}$$

Recalling the definition of effective stress (Chapter II) and comparing Eqs. (5.16) and (5.50), we see that a correspondence is obtained by setting

$$Y_1 = \frac{2\tau_0}{n\sin 2\alpha} - \frac{\mu_f}{\sin 2\alpha}\left[\left(\overset{(1)}{\sigma}_x{}^{e} + \overset{(1)}{\sigma}_y{}^{e}\right) + 2\overset{(2)}{p}{}^{e} + \left(\overset{(1)}{\sigma}_x{}^{e} - \overset{(1)}{\sigma}_y{}^{e}\right)\cos 2\alpha\right] \tag{5.51}$$

This value is used to determine the range of validity of Eq. (5.18) which holds for the elastic regime. For the "plastic" regime, however, we set $\tau_0 = 0$ when substituting (5.51) into (5.16) since the cohesive shear strength vanishes on the failure plane.

Current computer codes based on classical continuum mechanics do not permit the shear strength to depend directly on the stress state of the individual water and rock components. This capability in TINC, as represented by Eq. (5.51), is likely to have its greatest effect at the front of the shock where the effective stresses in the rock matrix and pore fluid have their greatest difference (see 3SR-267).

Ability to explicitly treat the pore fluid is not only important in treating shear strength, but has also been shown to drastically affect the velocity of dilatational and shear elastic waves in rocks (see, e.g., Nur and Simmons[40, 41]). According to these authors, the presence of a fluid phase in porous rocks constitutes one of the environmental factors that must be considered when in situ seismic velocities are investigated.

5.5.2 Non-Darcian Flow in a Fluid Saturated Porous Solid

The expression for diffusive resistance, $\rho_0 \eta$, introduced in Section 5.1, is based upon Darcy's law. Darcy (see article by A. Verruijt in Ref. 32) postulated the equation of motion of a fluid through a porous medium in a form which in TINC notation becomes

$$w - v = \frac{-K}{(1-n)\ \overset{(2)}{\rho}{}^{e}\ g} \frac{\partial \overset{(2)}{p}{}^{e}}{\partial x} = - \frac{K}{(1-n)^2\ \overset{(2)}{\rho}{}^{e}\ g} \frac{\partial \overset{(2)}{p}}{\partial x} \qquad (5.52)$$

where K = fluid conductivity

g = gravity.

The fluid conductivity K is related to premeability, k, as follows:

$$k = \frac{\mu K}{\overset{(2)}{\rho}{}^{e} g} \tag{5.53}$$

where

μ = kinematic viscosity of the fluid.

Permeability k has the dimensions of L^2 and is usually measured in darcies (1 darcy = 0.987×10^{-8} cm^2).

Equation (5.53) may be used to rewrite Eq. (5.52) as follows:

$$-\frac{\partial \overset{(2)}{p}}{\partial x} = \frac{(1-n)^2 \overset{(2)}{\rho}{}^{e} g}{K} (w-v) = \frac{(1-n)^2 \mu}{k} (w-v) \; . \tag{5.54}$$

Equating the left-hand side to $\rho_0 \eta$ (see Ishihara[30]), we obtain the following expression for 'd':

$$d = \frac{(1-n)^2 \mu}{k \rho_0} \tag{5.55}$$

In the TINC development so far, d has been taken to be a constant. The constant 'd' is computed by taking $n = n_0$ and μ and k as constants.

As has been pointed out by several authors (e.g., articles by Swartzendruber in Ref. 32), fluid flow through porous media becomes non-Darcian for large velocity or pressure gradients. We point out here that n, μ and k can be regarded as constants only over a small change of pressures. In this case, Eq. (5.54) may be replaced by (see Swift, et al., Ref. 42):

$$\rho_0 \eta = - \frac{\partial \overset{(2)}{p}}{\partial x} = \rho_0 \left\{ d_1 (w-v) + d_2 (w-v)^2 + \ldots \right\} \tag{5.56}$$

where d_i, i = 1, 2, ..., are constants. Alternatively, Eq. (5.54) may be expressed as

$$\rho_0 \eta = - \frac{\partial \overset{(2)}{p}}{\partial x} = \rho_0 \, d\left(\overset{(1)}{p}{}^e, \overset{(2)}{p}{}^e \right) (w-v) \tag{5.57}$$

where d is a function of pressure. However, at the present time, the available data do not permit the use of more exact laws like Eq. (5.57).

5.6 MAJOR MODIFICATIONS OF TINC FORMULATION

During this past year, work has been initiated to extend the TINC model to include (a) more realistic plasticity models and (b) thermodynamic description of the constituents. The present status of this effort is reviewed in the following sections.

5.6.1 Irreversible Void Collapse and Finite Deformation Plasticity

In order to model the dynamic behavior of geologic materials for use in numerical studies it is necessary to determine the stresses from the strains, strain rates and possibly a variety of other parameters that describe the physical state and the history of the material. Since the microstructure in geological materials is generally more complex than in metals, involving cracks, grains and voids which may contain water, it is not surprising that the observed behavior is also more complex, and that the assumption of ideal plasticity, which is often adequate for metals, fails to describe the response adequately.

Rocks exhibit inelastic compaction (volume decrease) at low pressures. This is primarily due to void collapse and can be modelled as a separate mechanism (see Chapter IV). At higher stress levels, prior to gross fracture, brittle rocks exhibit dilatancy (permanent volume increase) accompanying microfracture (opening of small cracks). As with compaction under isotropic pressure, it is possible to model dilatancy as a distinct isotropic microfracture mechanism depending primarily on shear, and not through a plastic flow rule. The finite deformation plasticity model discussed below assumes a non-porous solid and permits appropriate superposition of void collapse and dilatancy behaviors. A stress-strain curve

taken from Swanson's Ph.D. thesis[43] and shown in Fig. 5.12 illustrates the behavior of granite, including the highly non-linear stress-strain relation on first loading, the absence of a definite yield point and the complex unloading path. The data presented shows that there is no substantial range over which linear elastic behavior is observed either in loading or in unloading. A further indication of the deviation from ideal plasticity is that the slope at initial loading is only about half the slope at initial unloading, whereas in metals these slopes are usually equal to a good approximation. The apparent yielding during unloading, before the stress changes in sign, indicates a substantial Bauschinger effect. This kind of behavior has been explained by Hill,[44] as a consequence of residual stresses left in the material as a result of its grainy structure. The release of these stresses and the slip-stick behavior at the grain and crack boundaries can explain in qualitative fashion yielding prior to stress reversal. A model consisting of two springs and exhibiting this kind of behavior is shown in Fig. 5.13. The force-displacement curve under cyclic loading, also illustrated in the figure, is of the bilinear hysteresis type.

Often in metal plasticity the hardening that takes place as plastic deformation proceeds is represented by a constitutive law which allows the flow stress to depend on the plastic work. This kind of hardening is isotropic, and can be viewed in stress space as an expansion of the yield surface as a function of the plastic work done. Alternatively, a scalar measure of strain can be used as the parameter. Morland has examined in detail the consequences of isotropic hardening in plane and spherical wave propagation and the results are included in Ref. 45 . Such a representation is mathematically convenient and appears to be justified by certain test data, as discussed by Hill, but it does not

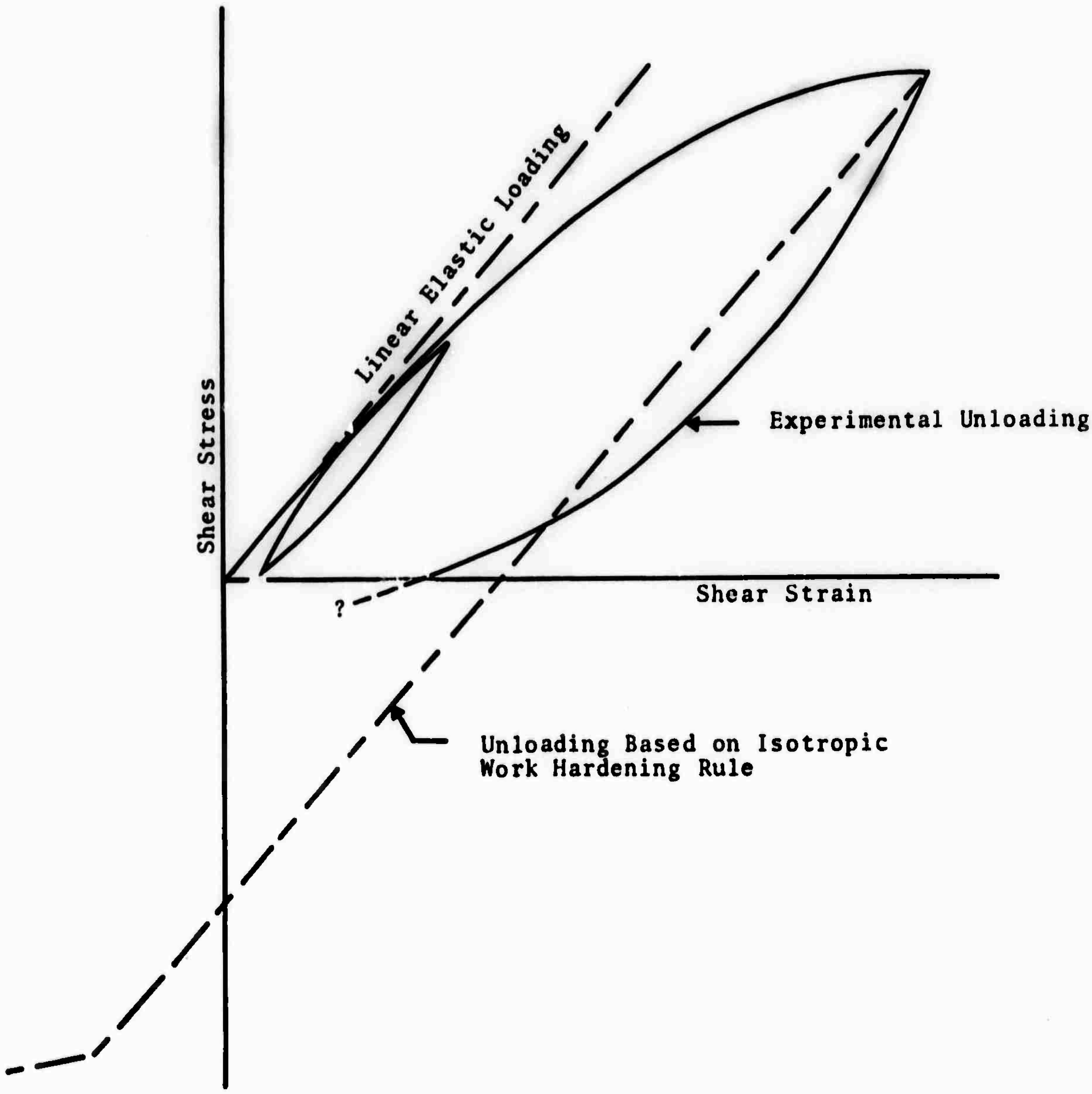

Fig. 5.12--Illustrates the difference between an isotropic model of work hardening and experimental result. Experimental data taken from Fig. 52 of Swanson's thesis, Ref. 43.

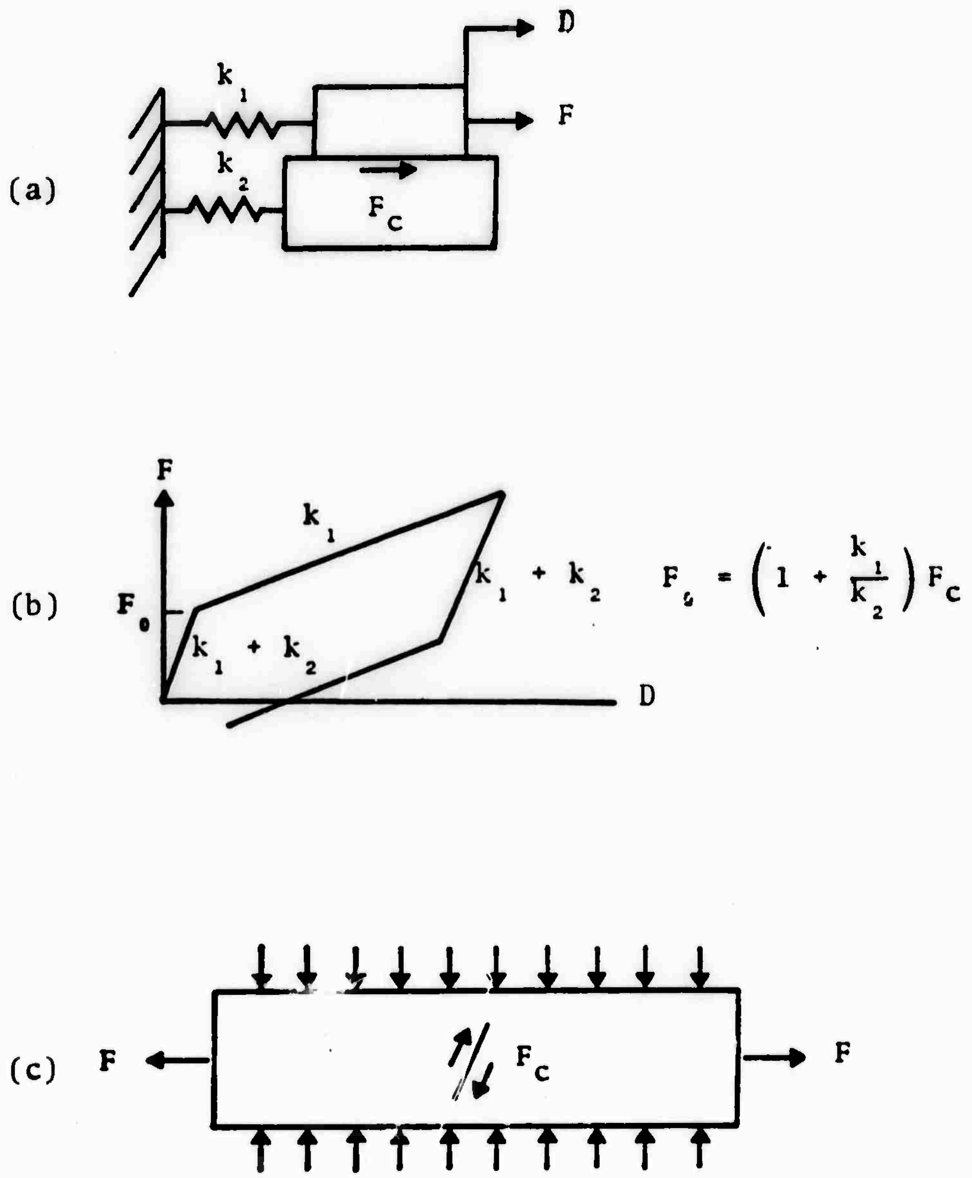

Fig. 5.13--A model exhibiting bilinear hysteresis is shown in (a) which consists of two springs and a dry friction element. The associated force-displacement curve is shown in (b). A continuum element which exhibits this kind of behavior is illustrated in (c).

allow for hysteresis effects adequately, as pointed out by Mroz,[46] since after one cycle of a periodically varying applied stress, no further hysteresis would occur. This is illustrated in Fig. 5.14 for one-dimensional stress states. Viewed in stress space, the yield surface expands under the influence of work hardeneing, but does not contract. Since the yield surface is unchanged during unloading, when the stress is reversed, from σ to $-\sigma$ no further hardening takes place. Then when the stress is reversed once more, the last path is followed in a reverse direction without hysteresis and without a Bauschinger effect. Consequently, the work hardening model does not accurately represent flows in which there may be multiple stress reversals, although the first loading can be described.

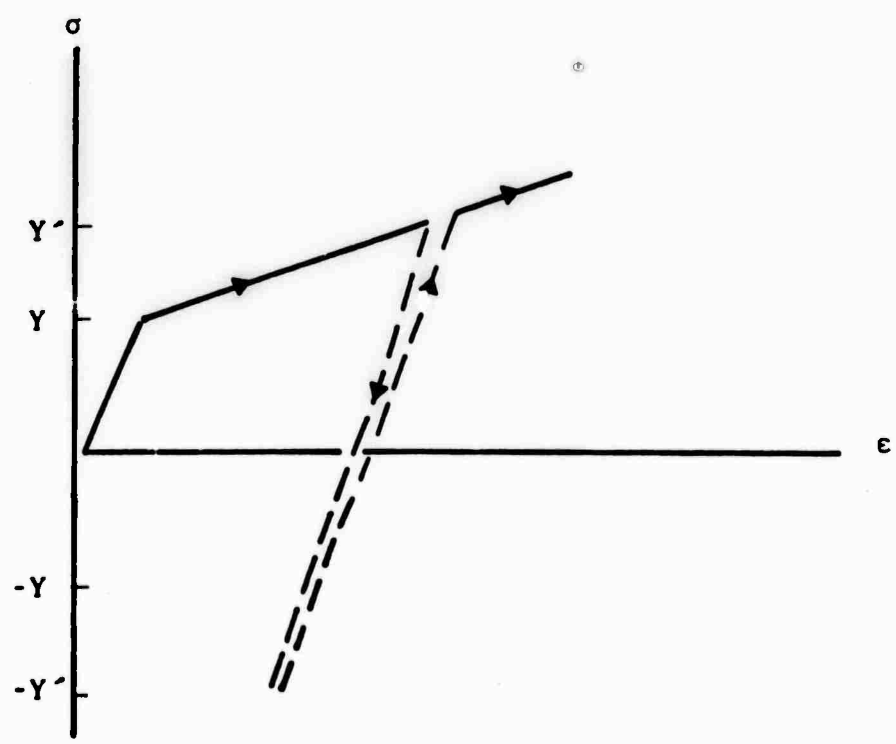

Fig. 5.14--Illustration of the stress-strain behavior predicted by an isotropic work hardening rule.

Although the assumption of isotropic hardening makes analytical studies tractable, it does not appear necessary in formulating equations for numerical integration. Since the experimental evidence suggests that the inelastic deformation of geologic materials is highly anisotropic, a constitutive equation making use of the kinematic hardening model, which describes anisotropic behavior, was investigated. According to this hardening rule the yield surface does not change its initial form and orientation, but translates in stress space as a rigid body. The concept was introduced by Prager[47] and later generalized by Ziegler,[48] and Mroz.[46] In the case of one-dimensional stress the model is equivalent to bilinear hysteresis, an approximation to material behavior that is common in the literature of applied mechanics. The analysis developed by Morland[45] follows the general approach to continuum flow outlined by Truesdell[29] and applied by Lee[49] to plasticity, is not restricted to small deformations. Since this approach does not impose any restriction on the analysis, it was also followed in developing the kinematic work hardening model.

The flow stress in geologic materials is known to depend on the pressure. A constitutive equation representing this behavior and based on the Mohr-Coulomb yield criterion was investigated by Drucker and Prager.[50] They assumed a conical yield surface and made use of the von Mises concept of a plastic potential to derive a flow law. Since we are not seeking analytical solutions, the yield surface can have an arbitrary shape. A free choice of hardening rule, based on the observed hysteresis, in combination with a yield surface fitted to the correct pressure dependence should make it possible to fit relatively complex soil or rock behavior.

The velocity gradient, $\underset{\sim}{G}$, (in Truesdell notation) can be written as the sum of a symmetric term, $\underset{\sim}{D}$, the strain rate, and an antisymmetric term, $\underset{\sim}{W}$, the spin,

$$\underset{\sim}{G} = \underset{\sim}{D} + \underset{\sim}{W} \tag{5.58}$$

Furthermore, the deformation gradient, F, defined by

$$\underset{\sim}{F} = \nabla \underset{\sim}{X} \ (X,t) \tag{5.59}$$

can be separated into the product of a unitary matrix, $\underset{\sim}{R}$, and a stretch matrix, $\underset{\sim}{U}$, by the Cauchy polar decomposition theorem,

$$\underset{\sim}{F} = \underset{\sim}{R}\,\underset{\sim}{U} \ . \tag{5.60}$$

Truesdell[29] shows that for any deformation with fixed principal axes the stretch and strain rate are related by

$$\underset{\sim}{D} = \frac{1}{2}\,\underset{\sim}{R}\left(\dot{\underset{\sim}{U}}\,\underset{\sim}{U}^{-1} + \underset{\sim}{U}^{-1}\,\dot{\underset{\sim}{U}}\right)\underset{\sim}{R}^{T} \tag{5.61}$$

The principal values, λ_i, of the stretch tensor and the principal strains are related by $\varepsilon_i = \ell n\left(\lambda_i\right)$. In numerical work it appears natural to use the velocity field to calculate the strain rate matrix, and to relate the stresses to the strain rate through an appropriate constitutive law. In the elastic case the stress rate is linear in $\underset{\sim}{D}$.

An isotropic constitutive law for the plastic component, $\underset{\sim}{D}^P$, of $\underset{\sim}{D}$ can be written in the form

$$\underset{\sim}{D}^P = \lambda\left(\psi_0 \underset{\sim}{I} + \psi_1\,\underset{\sim}{\sigma} + \psi_2\,\underset{\sim}{\sigma}^2\right) \tag{5.62}$$

where $\underset{\sim}{\sigma}$ is the stress, the ψ_i are arbitrary functions and λ is a parameter to be determined by the condition that the stress state is on the yield surface, which is given by an

equation of the form

$$\sqrt{J_2} = g\left(Y, J_1\right) \tag{5.63}$$

where J_1 and J_2 are the first and second invariants of the stress tensor. In kinematic hardening the yield surface is described by a modified stress,

$$\bar{\underset{\sim}{\sigma}} = \underset{\sim}{\sigma} - \underset{\sim}{\alpha} \tag{5.64}$$

representing a vector in stress space drawn to the yield surface from its center, specified by $\underset{\sim}{\alpha}$. Modified stress invariants are defined by

$$\bar{J}_1 = \bar{\sigma}_{ii} \tag{5.65a}$$

$$\bar{J}_2 = \frac{1}{2}\left(\sigma_{ij} - \alpha_{ij}\right)\left(\sigma_{ij} - \alpha_{ij}\right) \tag{5.65b}$$

where σ_{ij} denotes the components of the matrix $\underset{\sim}{\sigma}$. In kinematic hardening the yield surface is written

$$\sqrt{\bar{J}_2} = g\left(Y_1, \bar{J}_1\right) \tag{5.66}$$

Translation of the yield surface can be described in a variety of ways to represent the observed hardening behavior. The simplest assumption, originally proposed by Prager, makes the translation proportional to the plastic strain rate

$$\dot{\underset{\sim}{\alpha}} = b\, \underset{\sim}{D}^P \tag{5.67}$$

with b a constant proportional to the tangent modulus. Modifications, such as the one proposed by Ziegler

$$\dot{\underset{\sim}{\alpha}} = \dot{\mu}\left(\underset{\sim}{\sigma} - \underset{\sim}{\alpha}\right) \tag{5.68}$$

can be used to provide better fits to the observed hardening behavior.

The Prager hardening law has been programmed as a subroutine in the SKIPPER code, but no test runs have been made to investigate the effect of finite deformation or anisotropic hardening on wave propagation. Under the assumption that the yield surface is a right circular cone with half angle, ϕ, a parameter study involving several values of hardening modulus, b, and the cone angle, ϕ, is planned. On the basis of the results, plans for calculations involving a more accurate representation of the pressure dependence and the hardening law will be formulated. The isotropic hardening models developed by Morland and by DiMaggio and Sandler[51] can be incorporated into the existing strain hardening subroutine with relatively little additional effort. Should this be done, it would become possible to compare ground motion assuming anisotropic hardening only and work hardening only. When a hardening model has been validated in a single-continuum code (SKIPPER), it will be incorporated into the TINC framework.

5.6.2 Extension of TINC to Include Thermodynamic Effects

In the preceeding sections, the TINC model was developed within the confines of a mechanical theory in which explicit energy dependence is not considered. For many applications, the mechanical approximation is not valid and the full thermodynamic TINC model is required.

We shall restrict our attention to strain-rate independent (but not path independent) elastic-plastic materials. For such materials, $\overset{(\alpha)}{\underset{\sim}{\sigma}}{}^{e}$, depends only upon the current deformation gradient, $\overset{(\alpha)}{\underset{\sim}{F}}{}^{e}$, elastic internal energy, $\overset{(\alpha)}{E}_{el}$ and plastic work, $\overset{(\alpha)}{W}_{pl}$. Mathematically, the constitutive law for the constituent $\overset{(\alpha)}{s}$ as a single continuum may be expressed as

$$\underset{\sim}{\sigma} = g_{\alpha}\left(\underset{\sim}{F}, E_{el}, W_{pl}\right) \tag{5.69}$$

where the response function g_α applies to a reference configuration with initial density, ρ_0. In accordance with our earlier formulation of the mechanical model, the constitutive law for $\overset{(\alpha)}{\sigma}$ within the mixture may be written as:

$$\overset{(\alpha)}{\underset{\sim}{\sigma}} = \overset{(\alpha)}{n}\ g\left\{\left(\frac{\overset{(\alpha)}{n}}{\overset{(\alpha)}{n}_0}\right)^{1/3} \overset{(\alpha)}{\underset{\sim}{F}}, \overset{(\alpha)}{E}_{el}, \overset{(\alpha)}{W}_{pl}\right\} \tag{5.70}$$

Consistent with the assumption that dilatational and shear behaviors can be decoupled, the internal energy may be divided into dilatational internal energy, E_d, and shear internal energy, E_s. For the case when plastic incompressibility holds, E_s is the sum of W_{pl} and an elastic component, E_e'. Thus

$$\begin{aligned} E_d &= E_d + E_e' \\ W_p &= E_s - E_e' \end{aligned} \tag{5.71}$$

In general $\overset{(\alpha)}{n}$ are functions of the deformations and the thermodynamic states of all constituents. We make the postulate that they depend only upon the current Jacobians, $\overset{(\alpha)}{J} = \overset{(\alpha)}{\rho}_0 / \overset{(\alpha)}{\rho}$, of the deformation and the temperatures, $\overset{(\alpha)}{T}$:

$$\overset{(\alpha)}{n} = \overset{(\alpha)}{n}\left(\overset{(1)}{J}, \ldots, \overset{(r)}{J}; \overset{(1)}{T}, \ldots, \overset{(r)}{T}\right) \tag{5.72}$$

To discuss the determination of $\overset{(\alpha)}{n}$, it is convenient to consider a binary mixture. In this case, we are concerned with a single function, n, of four arguments $\left(\overset{(1)}{J}, \overset{(2)}{J}, \overset{(1)}{T}, \overset{(2)}{T}\right)$. The mixture pressure is given by

$$p = n\, P_1\left(\frac{n}{n_0}\overset{(1)}{J}, \overset{(1)}{T}\right) + (1-n)\, P_2\left(\frac{1-n}{1-n_0}\overset{(2)}{J}, \overset{(2)}{T}\right) \tag{5.73}$$

Here $p = P(J,T)$ and T defines, in some average sense, the temperature of the mixture. Given the mixture response $P(J,T)$ and the response of the individual constituents $P_1\left(\overset{(1)}{J}, \overset{(1)}{T}\right)$ and $P_2\left(\overset{(2)}{J}, \overset{(2)}{T}\right)$, Eq. (5.73) serves an implicit equation for the interaction function n.

In order to complete the description of the model, we have also to make a constitutive assumption for the heat flux $\overset{(1)}{\hat{q}} \left(= - \overset{(2)}{\hat{q}}\right)$ into $\overset{(1)}{s}$ from $\overset{(2)}{s}$ constituent.* In case the times of interest are small, adiabatic assumption may be introduced $\left(\overset{(1)}{\hat{q}} = 0\right)$. On the other extreme, when times of interest are extremely large, the constituents may be assumed to be in thermal equilibrium $\left(\overset{(1)}{T} = \overset{(2)}{T}\right)$. In the intermediate range, it is necessary to develop suitable constitutive relations for $\overset{(1)}{\hat{q}}$ based upon the microstructure of the composite. This question will be examined in detail during the next phase of this program.

*See Chapter II for a more complete discussion of the heat flux assumption, especially Section 2.2.

VI. DISCUSSION

The introduction of the TINC framework in Chapter II has permitted us to consider shock wave propagation through a composite medium in very general terms. The assumption that a steady state condition is obtained behind the front was found to result in non-unique Hugoniot states in the composite even when the equations of state for the constituents are specified. To complete the analysis it is necessary to make hypotheses, either implicitly or explicitly, regarding the interaction forces between the constituents and the partition of the composite's shock energy among its constituents. The PEQ, P*EQ and PTEQ models presented in Chapter II correspond to three such hypotheses.

The development of the P*EQ model for calculating the completely crushed thermodynamic states for porous wet tuffs is an important contribution to calculating stress wave effects in geologic materials. It considers the substructure of the composite and provides for a physically realistic initial partition of the shock energy between the water and the tuff matrix. The energy partition lies between those calculated under the extreme assumptions represented by the PEQ and PTEQ models. To understand the relevance of laboratory gas gun experiments (where the P*EQ model is valid) to actual underground nuclear tests at the Nevada Test Site (where the PTEQ model is usually valid) it is necessary to have available both the P*EQ and PTEQ equations of state for porous wet tuff.

A series of experimental programs to measure stress wave effects both in the laboratory and at the Nevada Test Site has recently been initiated. It is recommended that continuations of the work reported here place emphasis on predictive calculations in support of the experimental

programs. Calculations with 1-D SKIPPER code would be conducted using the PEQ, P*EQ and PTEQ equations of state.

In preparation for these predictive and interpretive calculations it would be necessary to coalesce the treatment of the low pressure irreversible crushup models developed in Chapter IV with the P*EQ and PTEQ models for the completely crushed states. A preliminary model for combining the treatments for the two pressure regimes was presented for porous dry tuff, but the treatment must be generalized to combine the models for porous wet tuff. This work should have the highest priority of the modeling efforts in the continuation of this program. A table look-up method would be used to implement the coalesced equations of state into single continuum codes such as SKIPPER.

In Chapter V a summary was presented of a model that has been developed for treating the deviatoric response of geologic media. The model accounts for anisotropic work hardening and finite elastic strain. These two effects are not normally considered in even the more advanced current plasticity treatments. A parameter study utilizing the spherical mode of the 1-D SKIPPER code should be made to evaluate these effects for a geologic material with a large shear strength (e.g., granite). The parameter study should also include calculations using the Cap Model developed by Sandler and DiMaggio.[51] It is suggested that a constant energy source in a spherical cavity be employed and that the material parameters governing the flow and fracture models be varied over the range of uncertainty. This study of granite would continue the recent parameter study by Anderson[52] for $\overline{\text{NTS}}$ tuff.

The POROUS code calculations presented in Chapter V have shown that a step pulse propagating into a saturated medium will not reach a steady state if the TINC framework

is employed using a simple Darcy diffusion law. This question should be examined further in a series of parameter studies in which more realistic non-Darcian diffusion models are employed. The NTS porous wet tuff crushup model should be implemented into POROUS and exercised in these studies.

Since the TINC framework is ideally suited for treating the effect of pore pressure on the deviatoric response of a strong geologic material such as granite, an improved plasticity theory should be incorporated into the POROUS code. Finally, the extension of the TINC formulation to account for thermodynamic effects should be completed and the POROUS code modified to accomodate the expanded TINC formulation.

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APPENDIX A

LAMINATE HUGONIOT MODEL

In Chapter II, we derived the composite Hugoniot relations within the framework of the Theory of Interacting Continua. For laminated materials and fiber-reinforced composites, equivalent relations may also be derived from the usual continuum mechanics considerations, provided the wave is propagating in the direction of the interfaces.

The geometry to be considered is shown in Figs. A.1 and A.2. The flow in both constituents is assumed to be one-dimensional on either side of the control volume. The flow inside the control volume may be unsteady and two-dimensional. In accordance with Chapter II, the two constituents are required to be in pressure equilibrium outside the control volume.

If no voids open in the composite following passage of the shock front, compatibility of displacements requires

$$A_1 + A_2 = A_3 + A_4 \qquad \text{(A.1a)}$$

and

$$A_3 = A_1 + \varepsilon, \quad A_4 = A_2 - \varepsilon \qquad \text{(A.1b)}$$

Introducing

$$\sigma = A_3/A_4 \ , \qquad \text{(A.2a)}$$

We have

$$A_1/A_4 = \sigma - \sigma' \qquad \text{(A.2b)}$$

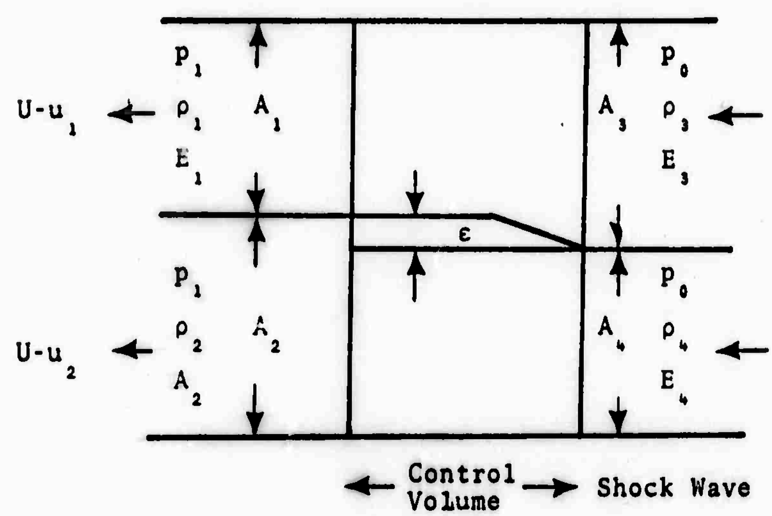

Fig. A.1--Schematic of control volume for a shock propagating in the laminated composite.

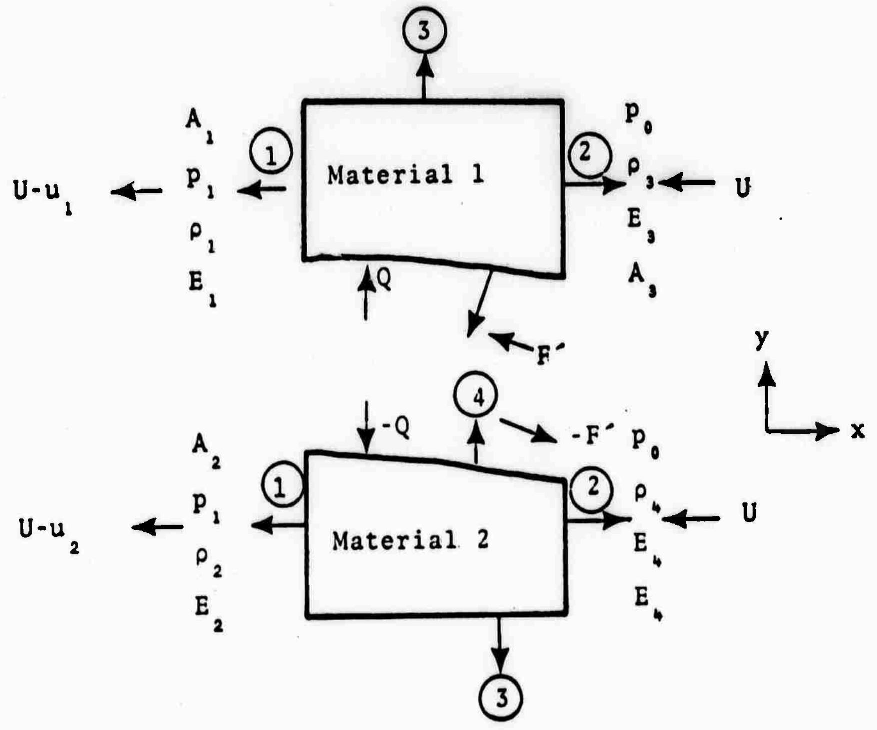

Fig. A.2--Control volume for the two constituents of a laminated composite.

and

$$A_2/A_4 = \sigma + \sigma' \,. \tag{A.2c}$$

To derive the conservation relations for the individual constituents in the composite, it is convenient to start with the conservation relations for a single material in the integral form.

The conservation of mass for a single material is given by

$$\int_S \rho \; v_j \; n_j \; dS = 0 \tag{A.3}$$

Integrating Eq. (A.3) along the surface of the control volumes in Fig. A.2 and remembering that

$$v_j \; n_j = 0 \text{ along } 3 \text{ and } 4 \,,$$

we obtain the following relations:

<u>1st Material</u>

$$\rho_1 \; A_1 \; (U-u_1) = \rho_3 \; A_3 \; U \tag{A.4}$$

<u>2nd Material</u>

$$\rho_2 \; A_2 \; (U-u_2) = \rho_4 \; A_4 \; U \tag{A.5}$$

On dividing both sides by A_4 , Eqs. (A.4) and (A.5) reduce to:

$$\rho_1 \; (\sigma - \sigma') \; (U - u_1) = \rho_3 \; \sigma \; U \tag{A.4a}$$

$$\rho_2 \; (1 + \sigma') \; (U - u_2) = \rho_4 \; U \quad . \tag{A.5a}$$

Equations (A.4a) and (A.5a) are identical with those given by Torvik[3]. By putting $u_1 = u_2 = u_0$, they are seen to be equivalent to those derived by Tsou and Chou[3].

Conservation of momentum for a single continuum is expressed by:

$$\int_S \rho \; v_i \; v_j \; n_j \; dS = - \int_S p \; n_i \; dS + \int_S f_i \; dS \; . \tag{A.6}$$

We note here that for the first material (x-direction)

$$\int_S f_1 \; dS = F_1' = - F \text{ (say)} \tag{A.7a}$$

and for the second material (x-direction)

$$\int_S f_1 \; dS = - F_1' = F \text{ (say)} \tag{A.7b}$$

Integrating Eq. (A.6) along the control volumes in Fig. A.2 and employing the continuity relations (A.4) and (A.5), we obtain:

1st Material

$$A_3 \; \rho_3 \; Uu_1 = p_1 \; A_1 - p_0 \; A_3 + p_m \; (A_3 - A_1) - F \tag{A.8}$$

2nd Material

$$A_4 \rho_4 U u_2 = p_1 A_2 - p_0 A_4 + p_m (A_4 - A_2) + F \qquad \text{(A.9)}$$

By substituting $p_m = (p_1 + p_0)/2$ and $F = 0$ Eqs. (A.8) and (A.9) may be shown to be equivalent to the momentum conservation relations of Torvik. Adding Eqs. (A.8)* and (A.9), and putting $u_1 = u_2 = u_0$, we have

$$u_0 \; U (\sigma\rho_3 + \rho_4) = (p_1 - p_0)(1 + \sigma) \qquad \text{(A.10)}$$

Equation (A.10) is seen to be the same as given by Tsou and Chou. Also by putting $u_1 = u_0$, we obtain from Eq. (A.8):

$$\frac{F}{\left(A_3 \rho_3 + A_4 \rho_4\right)U^2} = \frac{1}{1 + \frac{1}{\sigma}\frac{\rho_4}{\rho_3}} \left\{ \left[p_1 \left(1 - \frac{\sigma'}{\sigma}\right) - p_0 + p_m \frac{\sigma'}{\sigma} \right] / \rho_3 U^2 - u_0/U \right\} \qquad \text{(A.11)}$$

Equation (A.11) differs from that given by Tsou and Chou for the reasons discussed in Chapter II. Again, we point out that this difference is quite significant whenever σ' is large. At this juncture, it is also appropriate to note that F represents only the x-component of the interfacial shear force. Clearly, one cannot determine the total interfacial shear force F' from a steady-wave analysis without making additional assumptions concerning the variation of σ' with x inside the control volume. In general, there exists no a priori basis for such assumptions. Thus, we must conclude that whenever one desires to find F' (or the

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* p_m is some sort of average pressure acting on the curved boundary 4

interfacial shear stress), it is necessary to solve the 2-D unsteady flow problem.

The conservation of energy for a single material requires that

$$- \int_S q_j \, n_j \, dS + \int_S f_i \, v_i \, dS - \int_S p \, v_i \, n_i \, dS$$

$$= \int_S \rho \left(E + \frac{1}{2} v^2\right) v_j \, n_j \, dS \qquad \text{(A.12)}$$

We note here that

$$- \int_S q_j \, n_j \, ds = Q \text{ for the first material}$$

$$= -Q \text{ for the second material}$$

While no heat is assumed to flow into or out of the control volume of Fig. A.1, heat is allowed to flow from one constituent to the other within the control volume. Again $\int f_i \, v_i \, dS$ is zero for both the materials since the individual control volumes (Fig. A.2) remain fixed (referred to an observer moving with the shock front). In other words, the interfacial shear force does no work*. Integrating Eq. (A.12) for the two control volumes of Fig. A.2, we obtain for

*It should be noted that the energy conservation equations derived for the individual constituents do not explicitly contain "frictional heating" terms, even though friction is assumed to exist between the layered fluids (in the interaction region). Such a result is not contradictory, as frictional heating is the irreversible transformation of one form of energy to another (i.e., kinetic to thermal). Since the "heating" occurs <u>within</u> the confines of the control volume, it does not alter the basic energy conservation equation (see E. G. Saunders [53].

1st Material

$$Q - \left[A_1 \; p_1 \; (U-u_1) - A_3 \; p_0 \; U\right] = \rho_3 \; A_3 \; U \left[E_1 - E_3 + \frac{1}{2} u_1^2 - u_1 \; U\right] \tag{A.13}$$

and

2nd Material

$$-Q - \left[A_2 \; p_1 \; (U-u_2) - A_4 \; p_0 \; U\right] = \rho_4 \; A_4 \; U \left[E_2 - E_4 + \frac{1}{2} u_2^2 - u_2 \; U\right] \tag{A.14}$$

By putting $Q = 0$, one should be able to recover the case discussed by Torvik. However, the equations so obtained differ from those given by Torvik. The reader can easily ascertain that Torvik's derivation of energy equation is in error. Substituting $u_1 = u_2 = u_0$ into Eqs. (A.13) and (A.14) we obtain:

$$\frac{\sigma\rho_3}{\rho_4}(E_1 - E_3) + E_2 - E_4 - \frac{1}{2} u_0^2 \left(\frac{\sigma\rho_3}{\rho_4} + 1\right) - (1 + \sigma)\frac{p_0}{\rho_4}\frac{u_0}{U} = 0 \tag{A.15}$$

and

$$\frac{Q}{\frac{1}{2}(A_3 \; \rho_3 + A_4 \; \rho_4) \; U^3} = \frac{1}{1 + \frac{\rho_4}{\sigma\rho_3}}\left\{\frac{2}{U^2}\left(E_1 - E_3 - \frac{p_0}{\rho_3} + \frac{p_1}{\rho_1}\right) - \frac{u_0}{U}\left(2 - \frac{u_0}{U}\right)\right\} \tag{A.16}$$

Equations (A.15) and (A.16) are seen to be identical with those given by Tsou and Chou.

Equations (A.4), (A.5), (A.8), (A.9), A.13), and (A.14) are seen to be equivalent to Eqs. (2.31), (2.32), (2.36), (2.37), (2.40), and (2.41) of Chapter II on noting that

$$n_0 = \frac{A_3}{A_3 + A_4} \ , \qquad 1 - n_0 = \frac{A_4}{A_3 + A_4}$$

$$n = \frac{A_1}{A_1 + A_2} \ , \qquad 1 - n = \frac{A_2}{A_1 + A_2}$$

$$\overset{(1)}{\rho}_0{}^e = \rho_3 \ , \qquad \overset{(2)}{\rho}_0{}^e = \rho_4$$

$$\overset{(1)}{\rho}{}^e = \rho_1 \ , \qquad \overset{(2)}{\rho}{}^e = \rho_2$$

$$p^e = p_1 \ , \qquad p_0^e = p_0$$

$$\overset{(1)}{E}_0 = E_3 \ , \qquad \overset{(2)}{E}_0 = E_4$$

$$\overset{(1)}{E} = E_1 \ , \qquad \overset{(2)}{E} = E_2$$

$$\overline{F} = F/(A_1 + A_2) \ , \qquad \overline{Q} = Q/(A_1 + A_2) \ .$$

APPENDIX B
EQUATIONS OF STATE

A critical examination of the equations of state for NTS tuff and water presented in 3SR-267 revealed that some minor inconsistencies were implicit in their development. The basic form of the equations of state is unchanged:

$$P_i(V_i, E_i) = P_{Hi}(V_i)\left(1 - \frac{1}{2}\, G_i(V_i)\left(\frac{V_{0i}}{V_i} - 1\right)\right) + G_i(V_i)\,\Delta E_i/V_i \quad \text{(B.1)}$$

$$\Delta E_i(V_i, T_i) = C_{Vi}(T_i - T_0) + I_1(V_i) \quad \text{(B.2)}$$

where I_1 is given by

$$I_1(V_i) = -\int_{V_0}^{V_i} h_{1_i}(V)\,dV \quad \text{(B.3)}$$

and $h_1(V_i)$ is the zero degree isotherm of the materials.

<u>WATER</u>

In 3SR-267, the "hybrid" equation of state consisted of the empirical fit to the P-V-E Hugoniot data (for the P(V, E) relation) and a <u>separate</u> fit to isotherm data to obtain $h_1(V)$. This introduces an inconsistency since $h_1(V)$ is directly related to $P_H(V)$, $G(V)$ by the relation

$$P_H(V) = \left\{h_1(V) + \frac{G(V)}{V}\left[\int_{V_0}^{V} h_1(V)\,dV + P_0\frac{1}{2}\left(V_0 - V\right) + C_V T_0\right]\right\} \Big/ \left(1 - \frac{G(V)}{2V}\left(V_0 - V\right)\right) \quad \text{(B.4)}$$

This has been resolved by suitable modifications to the thermal equation of state. The expanded liquid water states required a similar alteration to ensure continuity across the line, $V = V_0$. Thus, the P-V-E equation of states for water remain the same as in 3SR-267. The $h_1(V)$ corrections were achieved by fitting a seventh degree polynomial in $\mu = \left(\frac{V_0}{V} - 1\right)$ to the P-V-E isentrope passing through $P = 0$, $E = - C_V T_0$ (i.e., the zero degree isotherm). Care was taken to have

$$h_1(V_0) = - \frac{G}{V_0} C_V T_0 + 10^6 \qquad \text{(B.5)}$$

in agreement with Eq. (B.4).

The liquid water equations of state are summarized in Table B.1. No changes were required for the two-phase regime (see 3SR-267), although two corrections should be made for K_2 and K_5 in Table 2.2 on page 57. These expressions should read

$$K_2 = -1.203374 \times 10^{-3}$$
$$K_5 = -3.946263 \times 10^{-3}$$

NTS TUFF

A discrepancy in the NTS tuff equation of state coding resulted in the utilization of a value for C_V ten times lower than the value assumed for NTS tuff (i.e., $C_V = .2$ cal/g °K = $.814 \times 10^7$ ergs/gm °K). Thus, the tuff temperatures reported in 3SR-267 overestimate the true theoretical prediction. This required recalculation of the PTEQ states, since temperature equilibration is employed as a major constraint in the mixture formulation. In addition, the compression energy integral was refit so that Eq. (B.5) was satisfied. The corrected NTS tuff equation of state is given in Table B.2.

TABLE B.1

Water Equation of State

P-V-E Formulation

$$P(V, E) = P_H(V)\left(1 - \frac{1}{2} G(V)\mu\right) + \frac{G(V)}{V} E$$

where, for compressed states $(V < V_0)$:

$$P_H(V) = A\mu + B\mu^2 + C\mu^3 + 10^6$$

$$\mu = \frac{V_0}{V} - 1, \quad V_0 = 1.0018 \text{ cm}^3/\text{gm}$$

$$A = 2.19534 \times 10^{10} \text{ dynes/cm}^2$$

$$B = 5.2138 \times 10^{10} \text{ dynes/cm}^2$$

$$C = 23.181 \times 10^{10} \text{ dynes/cm}^2$$

$$G(V) = 0.41 \sin (9.52V - 4.5676) + 0.94$$

and for expanded states $(V \geq V_0)$:

$$P_H(V) = \frac{h_1(V) + \frac{G}{V}\left(- I_1(V) + \frac{10^6}{2}(V_0 - V) + C_V T_0\right)}{1 - \frac{G}{2}\mu} + 10^6$$

where

$$G = .54$$

$$C_V = 3.26508 \times 10^7 \text{ ergs/gm °K}$$

$$T_0 = 293 \text{ °K}$$

$$I_1(V) = -\left[a_1\mu + a_2\mu^2 + \ldots + a_7\mu^7\right]$$

$a_1 = 0.0051670135 \times 10^{12}$ dynes/cm^2

$a_2 = -0.033020178 \times 10^{12}$ dynes/cm^2

$a_3 = -0.18218890 \times 10^{12}$ dynes/cm^2

$a_4 = -1.0206906 \times 10^{12}$ dynes/cm^2

$a_5 = -3.2479721 \times 10^{12}$ dynes/cm^2

$a_6 = -5.3896481 \times 10^{12}$ dynes/cm^2

$a_7 = -3.6120277 \times 10^{12}$ dynes/cm^2

$$h_1(V) = -\frac{d}{dV} I_1(V) = -\frac{V_0}{V^2}\left[a_1 + 2a_2\mu + \ldots + 7a_7\mu^6\right]$$

E-V-T Formulation

$$E(V, T) = C_V(T - T_0) + I_1(V)$$

where, for compressed states,

$$I_1(V) = -\left[a_1\mu + a_2\mu^2 + \ldots + a_2\mu^2\right],$$

$a_1 = 0.051670135 \times 10^{11}$ dynes/cm^2

$a_2 = -0.14298957 \times 10^{11}$ dynes/cm^2

$a_3 = 0.44038809 \times 10^{11}$ dynes/cm^2

$a_4 = -1.2139103 \times 10^{11}$ dynes/cm^2

$a_5 = 1.3362022 \times 10^{11}$ dynes/cm^2

$a_6 = -0.74059677 \times 10^{11}$ dynes/cm^2

$a_7 = 0.16449768 \times 10^{11}$ dynes/cm^2

For expanded states, see definition of P_H.

(C_V, T_0 as before)

TABLE B.2

NTS Tuff Equation of State

$$P(V, E) = P_H(V)\left(1 - \frac{1}{2}G\mu\right) + \frac{G}{V}E$$

where:

$$G = .33$$

$$P_H(V) = A\mu + B\mu^2 + C\mu^3 \ , \quad \mu = \frac{V_0}{V} - 1 \ ,$$

$$V_0 = \frac{1}{2.4}\ \text{cm}^3/\text{gm}$$

$$A = 2.4576 \times 10^{11}\ \text{dynes/cm}^2$$

$$B = 2.98697 \times 10^{11}\ \text{dynes/cm}^2$$

$$C = .614886 \times 10^{11}\ \text{dynes/cm}^2$$

$$E(V, T) = C_V(T - T_0) + I_1(V)$$

$$C_V = 0.8372 \times 10^7\ \text{ergs/gm °K}$$

$$I_1(V) = -\left[a_1\mu + a_2\mu^2 + \dots + a_7\mu^6\right] \quad \mu = \frac{V_0}{V} - 1$$

$$a_1 = .080948866 \times 10^{10}\ \text{dynes/cm}^2$$

$$a_2 = -5.1751998 \times 10^{10}\ \text{dynes/cm}^2$$

$$a_3 = 2.9781959 \times 10^{10}\ \text{dynes/cm}^2$$

$$a_4 = -3.2371834 \times 10^{10}\ \text{dynes/cm}^2$$

$$a_5 = 5.1987576 \times 10^{10}\ \text{dynes/cm}^2$$

$$a_6 = -6.0676891 \times 10^{10}\ \text{dynes/cm}^2$$

$$a_7 = 3.1072577 \times 10^{10}\ \text{dynes/cm}^2$$

CALCULATIONS

Due to the changes in the equations of state, new PTEQ Hugoniot calculations were required. The shock states for 0.0, 0.05, 0.10, 0.15, 0.20, 0.25, 0.30, and 1.00 values of M_W are provided in Table B.3.

The Hugoniot entropies and sound speeds for $\overline{\text{NTS}}$ tuff and water are provided in Table B.4.

Initial porosity PTEQ Hugoniots (assuming complete void collapse) are listed in Table B.5 for M_W = 0, 0.05, 0.15, 0.25, and 1.00 at porosities of 0.05, 0.10, 0.15, and 0.2. Two initially porous $\overline{\text{NTS}}$ tuff U-u curves are superposed on results presented in 3SR-267 in Fig. B.1. The agreement between the porous $\overline{\text{NTS}}$ equation of state and the experimental data is excellent. The minor discrepancy between theory and experiment for saturated and partially saturated tuff (see Figs. 3.14, 3.25) may be indicative of some mixture interaction effect (e.g., phase changes, quasi-steady experiments, etc.).

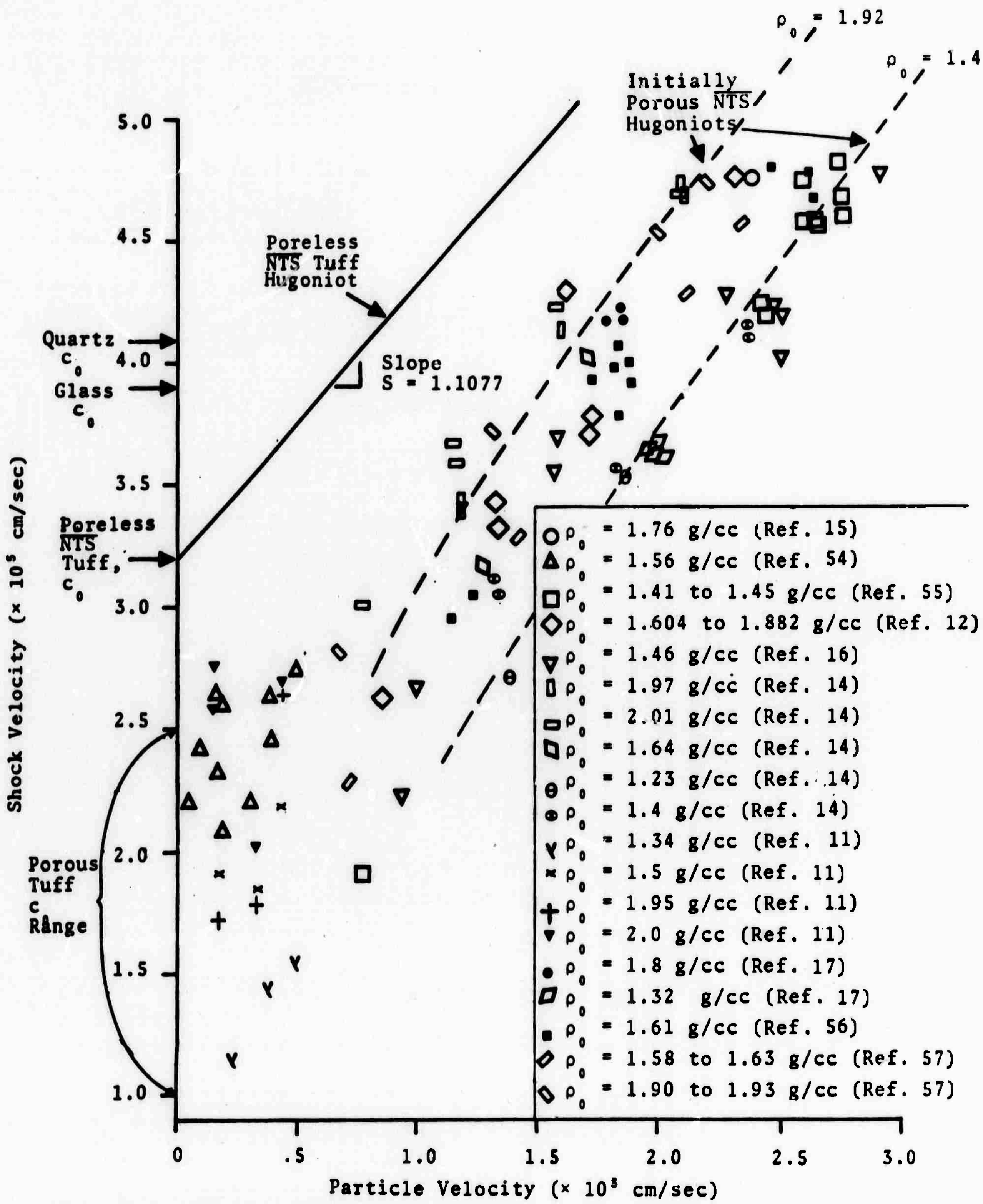

Fig. B.1--Shock velocity vs particle velocity for porous, dry tuffs. The theoretical NTS curves assume complete void collapse.

TABLE B.3

PTEQ Hugoniots - $\overline{\text{NTS}}$ tuff/water - Saturated

M_W = 0, .05, .10, .15, .2, .25, .3, 1.0

AIX = Energy of Mix, ergs/g
TVOL = Specific Volume of Mix, cc/g
P = Pressure, ergs/cc
Theta = Temperature, °K
Rho Water = Density of Water, g/cc
Rho Tuff = Density of Tuff, g/cc
SIE Water = Energy of Water, ergs/g
SIE Tuff = Energy of Tuff, ergs/g
Shock Vel = Shock Velocity, U, cm/sec
Part. Vel = Particle Velocity, u, cm/sec

.00 PERCENT WATER (M_W = 0, Poreless $\overline{\text{NTS}}$ Tuff)

K	AIX	TVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	3.847-01	2.252+10	3.032+02	9.982-01	2.599+00	3.600+08	3.600+08	3.497+05	2.683+04
2	7.200+08	3.730-01	3.296+10	3.107+02	9.982-01	2.681+00	7.200+08	7.200+08	3.620+05	3.793+04
3	1.080+09	3.646-01	4.133+10	3.190+02	9.982-01	2.742+00	1.080+09	1.080+09	3.714+05	4.637+04
4	1.440+09	3.578-01	4.882+10	3.271+02	9.982-01	2.795+00	1.440+09	1.440+09	3.794+05	5.362+04
5	1.800+09	3.520-01	5.562+10	3.358+02	9.982-01	2.841+00	1.800+09	1.800+09	3.864+05	5.998+04
6	2.160+09	3.470-01	6.194+10	3.450+02	9.982-01	2.882+00	2.160+09	2.160+09	3.928+05	6.571+04
7	2.520+09	3.425-01	6.790+10	3.547+02	9.982-01	2.920+00	2.520+09	2.520+09	3.986+05	7.099+04
8	2.880+09	3.383-01	7.377+10	3.636+02	9.982-01	2.956+00	2.880+09	2.880+09	4.042+05	7.605+04
9	3.240+09	3.346-01	7.917+10	3.743+02	9.982-01	2.989+00	3.240+09	3.240+09	4.092+05	8.061+04
10	3.600+09	3.312-01	8.441+10	3.853+02	9.982-01	3.020+00	3.600+09	3.600+09	4.140+05	8.495+04
11	3.960+09	3.280-01	8.948+10	3.965+02	9.982-01	3.049+00	3.960+09	3.960+09	4.186+05	8.908+04
12	4.320+09	3.250-01	9.442+10	4.081+02	9.982-01	3.077+00	4.320+09	4.320+09	4.229+05	9.302+04
13	4.680+09	3.222-01	9.923+10	4.199+02	9.982-01	3.103+00	4.680+09	4.680+09	4.271+05	9.681+04
14	5.040+09	3.196-01	1.039+11	4.320+02	9.982-01	3.129+00	5.040+09	5.040+09	4.311+05	1.004+05
15	5.400+09	3.171-01	1.085+11	4.444+02	9.982-01	3.154+00	5.400+09	5.400+09	4.350+05	1.040+05
16	5.760+09	3.147-01	1.131+11	4.570+02	9.982-01	3.178+00	5.760+09	5.760+09	4.388+05	1.074+05
17	6.120+09	3.124-01	1.175+11	4.699+02	9.982-01	3.201+00	6.120+09	6.120+09	4.424+05	1.107+05
18	6.480+09	3.103-01	1.219+11	4.830+02	9.982-01	3.223+00	6.480+09	6.480+09	4.459+05	1.139+05
19	6.840+09	3.082-01	1.262+11	4.963+02	9.982-01	3.245+00	6.840+09	6.840+09	4.494+05	1.170+05
20	7.200+09	3.062-01	1.304+11	5.099+02	9.982-01	3.266+00	7.200+09	7.200+09	4.527+05	1.200+05
21	7.560+09	3.043-01	1.346+11	5.236+02	9.982-01	3.286+00	7.560+09	7.560+09	4.560+05	1.230+05
22	7.920+09	3.024-01	1.387+11	5.376+02	9.982-01	3.306+00	7.920+09	7.920+09	4.592+05	1.259+05
23	8.280+09	3.007-01	1.428+11	5.518+02	9.982-01	3.326+00	8.280+09	8.280+09	4.623+05	1.287+05
24	8.640+09	2.990-01	1.468+11	5.661+02	9.982-01	3.345+00	8.640+09	8.640+09	4.654+05	1.315+05
25	9.000+09	2.973-01	1.508+11	5.807+02	9.982-01	3.364+00	9.000+09	9.000+09	4.683+05	1.342+05
26	9.360+09	2.957-01	1.548+11	5.954+02	9.982-01	3.382+00	9.360+09	9.360+09	4.713+05	1.368+05
27	9.720+09	2.941-01	1.587+11	6.103+02	9.982-01	3.400+00	9.720+09	9.720+09	4.741+05	1.394+05
28	1.008+10	2.926-01	1.625+11	6.254+02	9.982-01	3.417+00	1.008+10	1.008+10	4.770+05	1.420+05
29	1.044+10	2.912-01	1.664+11	6.406+02	9.982-01	3.435+00	1.044+10	1.044+10	4.797+05	1.445+05
30	1.080+10	2.897-01	1.702+11	6.560+02	9.982-01	3.451+00	1.080+10	1.080+10	4.824+05	1.470+05
31	1.116+10	2.883-01	1.739+11	6.716+02	9.982-01	3.468+00	1.116+10	1.116+10	4.851+05	1.494+05
32	1.152+10	2.870-01	1.777+11	6.873+02	9.982-01	3.484+00	1.152+10	1.152+10	4.878+05	1.518+05
33	1.188+10	2.859-01	1.809+11	7.074+02	9.982-01	3.498+00	1.188+10	1.188+10	4.900+05	1.538+05
34	1.224+10	2.846-01	1.846+11	7.235+02	9.982-01	3.514+00	1.224+10	1.224+10	4.926+05	1.561+05
35	1.260+10	2.833-01	1.883+11	7.389+02	9.982-01	3.530+00	1.260+10	1.260+10	4.951+05	1.585+05
36	1.296+10	2.821-01	1.920+11	7.545+02	9.982-01	3.545+00	1.296+10	1.296+10	4.977+05	1.608+05
37	1.332+10	2.808-01	1.957+11	7.702+02	9.982-01	3.561+00	1.332+10	1.332+10	5.002+05	1.631+05
38	1.368+10	2.796-01	1.994+11	7.861+02	9.982-01	3.576+00	1.368+10	1.368+10	5.026+05	1.653+05
39	1.404+10	2.785-01	2.030+11	8.022+02	9.982-01	3.591+00	1.404+10	1.404+10	5.051+05	1.675+05
40	1.440+10	2.773-01	2.067+11	8.184+02	9.982-01	3.606+00	1.440+10	1.440+10	5.074+05	1.697+05

TABLE B.3 (Continued)

.00 Percent Water (Continued)

41	1.476+10	2.762-01	2.102+11	8.348+02	9.982-01	3.620+00	1.476+10	1.476+10	5.098+05	1.718+05
42	1.512+10	2.751-01	2.138+11	8.513+02	9.982-01	3.635+00	1.512+10	1.512+10	5.121+05	1.740+05
43	1.548+10	2.741-01	2.174+11	8.680+02	9.982-01	3.649+00	1.548+10	1.548+10	5.144+05	1.760+05
44	1.584+10	2.730-01	2.209+11	8.848+02	9.982-01	3.663+00	1.584+10	1.584+10	5.167+05	1.781+05
45	1.620+10	2.720-01	2.244+11	9.018+02	9.982-01	3.676+00	1.620+10	1.620+10	5.189+05	1.802+05
46	1.656+10	2.710-01	2.279+11	9.190+02	9.982-01	3.690+00	1.656+10	1.656+10	5.211+05	1.822+05
47	1.692+10	2.700-01	2.313+11	9.362+02	9.982-01	3.703+00	1.692+10	1.692+10	5.233+05	1.842+05
48	1.728+10	2.691-01	2.348+11	9.536+02	9.982-01	3.716+00	1.728+10	1.728+10	5.255+05	1.861+05
49	1.764+10	2.661-01	2.382+11	9.711+02	9.982-01	3.730+00	1.764+10	1.764+10	5.276+05	1.881+05
50	1.800+10	6.142-01	9.286+10	9.055+02	1.628+00	2.400+00	1.800+10	1.800+10	4.904+05	1.897+05
51	1.836+10	6.127-01	9.435+10	8.149+02	1.632+00	2.400+00	1.836+10	1.836+10	4.933+05	1.916+05
52	1.872+10	6.112-01	9.583+10	8.242+02	1.636+00	2.400+00	1.872+10	1.872+10	4.962+05	1.935+05
53	1.908+10	6.097-01	9.731+10	8.335+02	1.640+00	2.400+00	1.908+10	1.908+10	4.991+05	1.953+05
54	1.944+10	6.083-01	9.878+10	8.428+02	1.644+00	2.400+00	1.944+10	1.944+10	5.019+05	1.972+05
55	1.980+10	6.069-01	1.003+11	8.521+02	1.648+00	2.400+00	1.980+10	1.980+10	5.048+05	1.990+05
56	2.016+10	6.055-01	1.017+11	8.615+02	1.652+00	2.400+00	2.016+10	2.016+10	5.075+05	2.008+05
57	2.052+10	6.041-01	1.032+11	8.708+02	1.655+00	2.400+00	2.052+10	2.052+10	5.103+05	2.026+05
58	2.088+10	6.028-01	1.046+11	8.801+02	1.659+00	2.400+00	2.088+10	2.088+10	5.130+05	2.043+05
59	2.124+10	6.015-01	1.061+11	8.894+02	1.663+00	2.400+00	2.124+10	2.124+10	5.157+05	2.061+05
60	2.160+10	6.002-01	1.075+11	8.987+02	1.666+00	2.400+00	2.160+10	2.160+10	5.184+05	2.078+05
61	2.196+10	5.989-01	1.090+11	9.080+02	1.670+00	2.400+00	2.196+10	2.196+10	5.210+05	2.095+05
62	2.232+10	5.976-01	1.104+11	9.173+02	1.673+00	2.400+00	2.232+10	2.232+10	5.236+05	2.113+05
63	2.268+10	5.964-01	1.119+11	9.266+02	1.677+00	2.400+00	2.268+10	2.268+10	5.262+05	2.130+05
64	2.304+10	5.952-01	1.133+11	9.359+02	1.680+00	2.400+00	2.304+10	2.304+10	5.288+05	2.146+05
65	2.340+10	5.940-01	1.147+11	9.452+02	1.684+00	2.400+00	2.340+10	2.340+10	5.313+05	2.163+05
66	2.376+10	5.928-01	1.162+11	9.545+02	1.687+00	2.400+00	2.376+10	2.376+10	5.339+05	2.180+05
67	2.412+10	5.916-01	1.176+11	9.638+02	1.690+00	2.400+00	2.412+10	2.412+10	5.364+05	2.196+05
68	2.448+10	5.905-01	1.190+11	9.731+02	1.694+00	2.400+00	2.448+10	2.448+10	5.388+05	2.212+05
69	2.484+10	5.893-01	1.204+11	9.824+02	1.697+00	2.400+00	2.484+10	2.484+10	5.413+05	2.229+05
70	2.520+10	5.882-01	1.218+11	9.917+02	1.700+00	2.400+00	2.520+10	2.520+10	5.437+05	2.245+05
71	2.556+10	5.871-01	1.232+11	1.001+03	1.703+00	2.400+00	2.556+10	2.556+10	5.461+05	2.261+05
72	2.592+10	5.860-01	1.247+11	1.010+03	1.706+00	2.400+00	2.592+10	2.592+10	5.485+05	2.277+05
73	2.628+10	5.849-01	1.261+11	1.020+03	1.710+00	2.400+00	2.628+10	2.628+10	5.509+05	2.292+05
74	2.664+10	5.839-01	1.275+11	1.029+03	1.713+00	2.400+00	2.664+10	2.664+10	5.532+05	2.308+05
75	2.700+10	5.828-01	1.289+11	1.038+03	1.716+00	2.400+00	2.700+10	2.700+10	5.556+05	2.324+05
76	2.736+10	5.818-01	1.303+11	1.047+03	1.719+00	2.400+00	2.736+10	2.736+10	5.579+05	2.339+05
77	2.772+10	5.808-01	1.317+11	1.057+03	1.722+00	2.400+00	2.772+10	2.772+10	5.602+05	2.354+05
78	2.808+10	5.798-01	1.330+11	1.066+03	1.725+00	2.400+00	2.808+10	2.808+10	5.625+05	2.370+05
79	2.844+10	5.788-01	1.344+11	1.075+03	1.728+00	2.400+00	2.844+10	2.844+10	5.647+05	2.385+05
80	2.880+10	5.778-01	1.358+11	1.085+03	1.731+00	2.400+00	2.880+10	2.880+10	5.670+05	2.400+05
81	2.916+10	5.768-01	1.372+11	1.094+03	1.734+00	2.400+00	2.916+10	2.916+10	5.692+05	2.415+05
82	2.952+10	5.759-01	1.386+11	1.103+03	1.737+00	2.400+00	2.952+10	2.952+10	5.714+05	2.430+05
83	2.988+10	5.749-01	1.400+11	1.112+03	1.739+00	2.400+00	2.988+10	2.988+10	5.736+05	2.444+05
84	3.024+10	5.740-01	1.413+11	1.122+03	1.742+00	2.400+00	3.024+10	3.024+10	5.758+05	2.459+05
85	3.060+10	5.731-01	1.427+11	1.131+03	1.745+00	2.400+00	3.060+10	3.060+10	5.780+05	2.474+05
86	3.096+10	5.721-01	1.441+11	1.140+03	1.748+00	2.400+00	3.096+10	3.096+10	5.801+05	2.488+05
87	3.132+10	5.712-01	1.455+11	1.150+03	1.751+00	2.400+00	3.132+10	3.132+10	5.823+05	2.503+05
88	3.168+10	5.703-01	1.468+11	1.159+03	1.753+00	2.400+00	3.168+10	3.168+10	5.844+05	2.517+05
89	3.204+10	5.695-01	1.482+11	1.168+03	1.756+00	2.400+00	3.204+10	3.204+10	5.865+05	2.531+05
90	3.240+10	5.686-01	1.496+11	1.177+03	1.759+00	2.400+00	3.240+10	3.240+10	5.886+05	2.545+05
91	3.276+10	5.677-01	1.509+11	1.187+03	1.761+00	2.400+00	3.276+10	3.276+10	5.907+05	2.559+05
92	3.312+10	5.669-01	1.523+11	1.196+03	1.764+00	2.400+00	3.312+10	3.312+10	5.928+05	2.574+05
93	3.348+10	5.660-01	1.536+11	1.205+03	1.767+00	2.400+00	3.348+10	3.348+10	5.948+05	2.587+05

TABLE B.3 (Continued)

NOT REPRODUCIBLE

.00 Percent Water (Continued

94	3.384+10	5.652-01	1.550+11	1.215+03	1.769+00	2.400+00	3.384+10	3.384+10	5.969+05	2.601+05
95	3.420+10	5.643-01	1.563+11	1.224+03	1.772+00	2.400+00	3.420+10	3.420+10	5.989+05	2.615+05
96	3.456+10	5.635-01	1.577+11	1.233+03	1.775+00	2.400+00	3.456+10	3.456+10	6.009+05	2.629+05
97	3.492+10	5.627-01	1.590+11	1.242+03	1.777+00	2.400+00	3.492+10	3.492+10	6.029+05	2.643+05
98	3.528+10	5.619-01	1.604+11	1.252+03	1.780+00	2.400+00	3.528+10	3.528+10	6.049+05	2.656+05
99	3.564+10	5.611-01	1.617+11	1.261+03	1.782+00	2.400+00	3.564+10	3.564+10	6.069+05	2.670+05
100	3.600+10	5.603-01	1.631+11	1.270+03	1.785+00	2.400+00	3.600+10	3.600+10	6.088+05	2.683+05
101	3.636+10	5.595-01	1.644+11	1.280+03	1.787+00	2.400+00	3.636+10	3.636+10	6.108+05	2.696+05
102	3.672+10	5.588-01	1.657+11	1.289+03	1.790+00	2.400+00	3.672+10	3.672+10	6.128+05	2.710+05
103	3.708+10	5.580-01	1.671+11	1.298+03	1.792+00	2.400+00	3.708+10	3.708+10	6.147+05	2.723+05
104	3.744+10	5.572-01	1.684+11	1.307+03	1.795+00	2.400+00	3.744+10	3.744+10	6.166+05	2.736+05
105	3.780+10	5.565-01	1.697+11	1.317+03	1.797+00	2.400+00	3.780+10	3.780+10	6.185+05	2.749+05
106	3.816+10	5.565-01	1.710+11	1.326+03	1.797+00	2.400+00	3.816+10	3.816+10	6.200+05	2.756+05
107	3.852+10	5.551-01	1.724+11	1.335+03	1.802+00	2.400+00	3.852+10	3.852+10	6.223+05	2.775+05
108	3.888+10	5.543-01	1.737+11	1.345+03	1.804+00	2.400+00	3.888+10	3.888+10	6.242+05	2.788+05
109	3.924+10	5.543-01	1.745+11	1.356+03	1.804+00	2.400+00	3.924+10	3.924+10	6.256+05	2.795+05
110	3.960+10	5.529-01	1.763+11	1.363+03	1.809+00	2.400+00	3.960+10	3.960+10	6.279+05	2.814+05
111	3.996+10	5.521-01	1.777+11	1.372+03	1.811+00	2.400+00	3.996+10	3.996+10	6.298+05	2.827+05
112	4.032+10	5.521-01	1.785+11	1.383+03	1.811+00	2.400+00	4.032+10	4.032+10	6.312+05	2.833+05
113	4.068+10	5.508-01	1.803+11	1.391+03	1.816+00	2.400+00	4.068+10	4.068+10	6.334+05	2.852+05
114	4.104+10	5.508-01	1.811+11	1.402+03	1.816+00	2.400+00	4.104+10	4.104+10	6.348+05	2.858+05
115	4.140+10	5.494-01	1.829+11	1.410+03	1.820+00	2.400+00	4.140+10	4.140+10	6.370+05	2.877+05
116	4.176+10	5.494-01	1.837+11	1.421+03	1.820+00	2.400+00	4.176+10	4.176+10	6.384+05	2.883+05
117	4.212+10	5.481-01	1.856+11	1.428+03	1.825+00	2.400+00	4.212+10	4.212+10	6.406+05	2.902+05
118	4.248+10	5.481-01	1.863+11	1.439+03	1.825+00	2.400+00	4.248+10	4.248+10	6.420+05	2.908+05
119	4.284+10	5.467-01	1.882+11	1.447+03	1.829+00	2.400+00	4.284+10	4.284+10	6.442+05	2.926+05
120	4.320+10	5.467-01	1.890+11	1.458+03	1.829+00	2.400+00	4.320+10	4.320+10	6.455+05	2.932+05
121	4.356+10	5.454-01	1.908+11	1.465+03	1.833+00	2.400+00	4.356+10	4.356+10	6.477+05	2.951+05
122	4.392+10	5.454-01	1.916+11	1.476+03	1.833+00	2.400+00	4.392+10	4.392+10	6.490+05	2.957+05
123	4.428+10	5.441-01	1.934+11	1.484+03	1.838+00	2.400+00	4.428+10	4.428+10	6.512+05	2.975+05
124	4.464+10	5.441-01	1.942+11	1.495+03	1.838+00	2.400+00	4.464+10	4.464+10	6.525+05	2.981+05
125	4.500+10	5.429-01	1.960+11	1.503+03	1.842+00	2.400+00	4.500+10	4.500+10	6.547+05	2.999+05
126	4.536+10	5.429-01	1.968+11	1.514+03	1.842+00	2.400+00	4.536+10	4.536+10	6.560+05	3.005+05
127	4.572+10	5.416-01	1.986+11	1.521+03	1.846+00	2.400+00	4.572+10	4.572+10	6.581+05	3.023+05
128	4.608+10	5.416-01	1.994+11	1.532+03	1.846+00	2.400+00	4.608+10	4.603+10	6.594+05	3.029+05
129	4.644+10	5.404-01	2.012+11	1.540+03	1.851+00	2.400+00	4.644+10	4.644+10	6.615+05	3.047+05
130	4.680+10	5.404-01	2.020+11	1.551+03	1.851+00	2.400+00	4.680+10	4.680+10	6.628+05	3.053+05
131	4.716+10	5.392-01	2.038+11	1.558+03	1.855+00	2.400+00	4.716+10	4.716+10	6.649+05	3.070+05
132	4.752+10	5.392-01	2.045+11	1.569+03	1.855+00	2.400+00	4.752+10	4.752+10	6.661+05	3.076+05
133	4.788+10	5.380-01	2.064+11	1.577+03	1.859+00	2.400+00	4.788+10	4.788+10	6.682+05	3.094+05
134	4.824+10	5.380-01	2.071+11	1.586+03	1.859+00	2.400+00	4.824+10	4.824+10	6.695+05	3.100+05
135	4.860+10	5.368-01	2.089+11	1.595+03	1.863+00	2.400+00	4.860+10	4.860+10	6.715+05	3.117+05
136	4.896+10	5.368-01	2.097+11	1.606+03	1.863+00	2.400+00	4.896+10	4.896+10	6.728+05	3.123+05
137	4.932+10	5.356-01	2.115+11	1.614+03	1.867+00	2.400+00	4.932+10	4.932+10	6.748+05	3.140+05
138	4.968+10	5.356-01	2.123+11	1.625+03	1.867+00	2.400+00	4.968+10	4.968+10	6.760+05	3.146+05
139	5.004+10	5.345-01	2.141+11	1.633+03	1.871+00	2.400+00	5.004+10	5.004+10	6.780+05	3.163+05
140	5.040+10	5.345-01	2.148+11	1.644+03	1.871+00	2.400+00	5.040+10	5.040+10	6.793+05	3.168+05
141	5.076+10	5.334-01	2.166+11	1.651+03	1.875+00	2.400+00	5.076+10	5.076+10	6.813+05	3.185+05
142	5.112+10	5.334-01	2.174+11	1.662+03	1.875+00	2.400+00	5.112+10	5.112+10	6.825+05	3.191+05
143	5.148+10	5.323-01	2.192+11	1.670+03	1.879+00	2.400+00	5.148+10	5.148+10	6.845+05	3.208+05
144	5.184+10	5.323-01	2.199+11	1.681+03	1.879+00	2.400+00	5.184+10	5.184+10	6.857+05	3.214+05
145	5.220+10	5.312-01	2.217+11	1.688+03	1.883+00	2.400+00	5.220+10	5.220+10	6.876+05	3.230+05
146	5.256+10	5.312-01	2.225+11	1.699+03	1.883+00	2.400+00	5.256+10	5.256+10	6.888+05	3.236+05
147	5.292+10	5.301-01	2.243+11	1.707+03	1.886+00	2.400+00	5.292+10	5.292+10	6.908+05	3.253+05

TABLE B.3 (Continued)

.00 Percent Water (Continued)

148	5.328+10	5.301-01	2.250+11	1.718+03	1.886+00	2.400+00	5.328+10	5.328+10	6.919+05	3.258+05
149	5.364+10	5.290-01	2.268+11	1.725+03	1.890+00	2.400+00	5.364+10	5.364+10	6.939+05	3.275+05
150	5.400+10	5.290-01	2.276+11	1.736+03	1.890+00	2.400+00	5.400+10	5.400+10	6.951+05	3.280+05
151	5.436+10	5.280-01	2.293+11	1.744+03	1.894+00	2.400+00	5.436+10	5.436+10	6.970+05	3.297+05
152	5.472+10	5.280-01	2.301+11	1.755+03	1.894+00	2.400+00	5.472+10	5.472+10	6.981+05	3.302+05
153	5.508+10	5.269-01	2.319+11	1.763+03	1.898+00	2.400+00	5.508+10	5.508+10	7.001+05	3.318+05
154	5.544+10	5.269-01	2.326+11	1.774+03	1.898+00	2.400+00	5.544+10	5.544+10	7.012+05	3.324+05
155	5.580+10	5.259-01	2.344+11	1.781+03	1.901+00	2.400+00	5.580+10	5.580+10	7.031+05	3.340+05
156	5.616+10	5.259-01	2.352+11	1.792+03	1.901+00	2.400+00	5.616+10	5.616+10	7.042+05	3.345+05
157	5.652+10	5.249-01	2.369+11	1.800+03	1.905+00	2.400+00	5.652+10	5.652+10	7.061+05	3.361+05
158	5.688+10	5.249-01	2.377+11	1.811+03	1.905+00	2.400+00	5.688+10	5.688+10	7.073+05	3.367+05
159	5.724+10	5.239-01	2.394+11	1.818+03	1.909+00	2.400+00	5.724+10	5.724+10	7.091+05	3.383+05
160	5.760+10	5.239-01	2.402+11	1.829+03	1.909+00	2.400+00	5.760+10	5.760+10	7.102+05	3.388+05
161	5.796+10	5.229-01	2.420+11	1.837+03	1.912+00	2.400+00	5.796+10	5.796+10	7.121+05	3.404+05
162	5.832+10	5.229-01	2.427+11	1.848+03	1.912+00	2.400+00	5.832+10	5.832+10	7.132+05	3.409+05
163	5.868+10	5.220-01	2.445+11	1.856+03	1.916+00	2.400+00	5.868+10	5.868+10	7.151+05	3.425+05
164	5.904+10	5.220-01	2.452+11	1.867+03	1.916+00	2.400+00	5.904+10	5.904+10	7.162+05	3.430+05
165	5.940+10	5.210-01	2.470+11	1.874+03	1.919+00	2.400+00	5.940+10	5.940+10	7.180+05	3.446+05
166	5.976+10	5.210-01	2.477+11	1.885+03	1.919+00	2.400+00	5.976+10	5.976+10	7.191+05	3.451+05
167	6.012+10	5.200-01	2.495+11	1.893+03	1.923+00	2.400+00	6.012+10	6.012+10	7.209+05	3.467+05
168	6.048+10	5.200-01	2.502+11	1.904+03	1.923+00	2.400+00	6.048+10	6.048+10	7.220+05	3.472+05
169	6.084+10	5.191-01	2.520+11	1.911+03	1.926+00	2.400+00	6.084+10	6.084+10	7.238+05	3.488+05
170	6.120+10	5.191-01	2.527+11	1.922+03	1.926+00	2.400+00	6.120+10	6.120+10	7.249+05	3.493+05
171	6.156+10	5.182-01	2.545+11	1.930+03	1.930+00	2.400+00	6.156+10	6.156+10	7.267+05	3.508+05
172	6.192+10	5.182-01	2.552+11	1.941+03	1.930+00	2.400+00	6.192+10	6.192+10	7.278+05	3.513+05
173	6.228+10	5.173-01	2.570+11	1.948+03	1.933+00	2.400+00	6.228+10	6.228+10	7.295+05	3.529+05
174	6.264+10	5.173-01	2.577+11	1.960+03	1.933+00	2.400+00	6.264+10	6.264+10	7.306+05	3.534+05
175	6.300+10	5.164-01	2.594+11	1.967+03	1.937+00	2.400+00	6.300+10	6.300+10	7.324+05	3.549+05
176	6.336+10	5.164-01	2.602+11	1.978+03	1.937+00	2.400+00	6.336+10	6.336+10	7.334+05	3.554+05
177	6.372+10	5.155-01	2.619+11	1.986+03	1.940+00	2.400+00	6.372+10	6.372+10	7.352+05	3.569+05
178	6.408+10	5.155-01	2.627+11	1.997+03	1.940+00	2.400+00	6.408+10	6.408+10	7.363+05	3.574+05
179	6.444+10	5.146-01	2.644+11	2.004+03	1.943+00	2.400+00	6.444+10	6.444+10	7.380+05	3.589+05
180	6.480+10	5.146-01	2.652+11	2.015+03	1.943+00	2.400+00	6.480+10	6.480+10	7.391+05	3.594+05
181	6.516+10	5.137-01	2.669+11	2.023+03	1.947+00	2.400+00	6.516+10	6.516+10	7.408+05	3.609+05
182	6.552+10	5.137-01	2.676+11	2.034+03	1.947+00	2.400+00	6.552+10	6.552+10	7.418+05	3.614+05
183	6.588+10	5.128-01	2.694+11	2.041+03	1.950+00	2.400+00	6.588+10	6.588+10	7.435+05	3.629+05
184	6.624+10	5.128-01	2.701+11	2.053+03	1.950+00	2.400+00	6.624+10	6.624+10	7.446+05	3.634+05
185	6.660+10	5.120-01	2.718+11	2.060+03	1.953+00	2.400+00	6.660+10	6.660+10	7.463+05	3.649+05
186	6.696+10	5.120-01	2.724+11	2.071+03	1.953+00	2.400+00	6.696+10	6.696+10	7.473+05	3.654+05
187	6.732+10	5.111-01	2.743+11	2.079+03	1.956+00	2.400+00	6.732+10	6.732+10	7.490+05	3.669+05
188	6.768+10	5.111-01	2.750+11	2.090+03	1.956+00	2.400+00	6.768+10	6.768+10	7.500+05	3.674+05
189	6.804+10	5.103-01	2.768+11	2.097+03	1.960+00	2.400+00	6.804+10	6.804+10	7.517+05	3.688+05
190	6.840+10	5.103-01	2.775+11	2.108+03	1.960+00	2.400+00	6.840+10	6.840+10	7.528+05	3.693+05
191	6.876+10	5.095-01	2.792+11	2.116+03	1.963+00	2.400+00	6.876+10	6.876+10	7.544+05	3.708+05
192	6.912+10	5.095-01	2.800+11	2.127+03	1.963+00	2.400+00	6.912+10	6.912+10	7.554+05	3.713+05
193	6.948+10	5.086-01	2.817+11	2.135+03	1.966+00	2.400+00	6.948+10	6.948+10	7.571+05	3.727+05
194	6.984+10	5.086-01	2.824+11	2.146+03	1.966+00	2.400+00	6.984+10	6.984+10	7.581+05	3.732+05
195	7.020+10	5.078-01	2.841+11	2.153+03	1.969+00	2.400+00	7.020+10	7.020+10	7.598+05	3.746+05
196	7.056+10	5.078-01	2.849+11	2.164+03	1.969+00	2.400+00	7.056+10	7.056+10	7.608+05	3.751+05
197	7.092+10	5.070-01	2.866+11	2.172+03	1.972+00	2.400+00	7.092+10	7.092+10	7.624+05	3.765+05
198	7.128+10	5.070-01	2.873+11	2.183+03	1.972+00	2.400+00	7.128+10	7.128+10	7.634+05	3.770+05
199	7.164+10	5.062-01	2.890+11	2.190+03	1.975+00	2.400+00	7.164+10	7.164+10	7.651+05	3.785+05

TABLE B.3 (Continued)

.00 Percent Water (Continued)

200	7.200+10	5.062-01	2.898+11	2.201+03	1.975+00	2.400+00	7.200+10	7.200+10	7.660+05	3.789+05
201	7.236+10	5.055-01	2.915+11	2.209+03	1.978+00	2.400+00	7.236+10	7.236+10	7.677+05	3.803+05
202	7.272+10	5.055-01	2.922+11	2.220+03	1.978+00	2.400+00	7.272+10	7.272+10	7.686+05	3.808+05
203	7.308+10	5.047-01	2.939+11	2.228+03	1.981+00	2.400+00	7.308+10	7.308+10	7.703+05	3.822+05
204	7.344+10	5.047-01	2.946+11	2.239+03	1.981+00	2.400+00	7.344+10	7.344+10	7.712+05	3.827+05
205	7.380+10	5.039-01	2.963+11	2.246+03	1.985+00	2.400+00	7.380+10	7.380+10	7.729+05	3.841+05
206	7.416+10	5.039-01	2.971+11	2.257+03	1.985+00	2.400+00	7.416+10	7.416+10	7.738+05	3.846+05
207	7.452+10	5.031-01	2.988+11	2.265+03	1.988+00	2.400+00	7.452+10	7.452+10	7.754+05	3.860+05
208	7.488+10	5.031-01	2.995+11	2.276+03	1.988+00	2.400+00	7.488+10	7.488+10	7.764+05	3.865+05
209	7.524+10	5.024-01	3.012+11	2.283+03	1.991+00	2.400+00	7.524+10	7.524+10	7.780+05	3.878+05

TABLE B.3 (Continued)

5 PERCENT WATER (M_W = .05)

K	AIX	TVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	4.074-01	1.870+10	3.159+02	1.338+00	2.567+00	3.331+07	3.772+08	3.107+05	2.683+04
2	7.200+08	3.946-01	2.808+10	3.292+02	1.424+00	2.642+00	6.999+08	7.211+08	3.300+05	3.794+04
3	1.080+09	3.855-01	3.575+10	3.415+02	1.484+00	2.700+00	1.419+09	1.062+09	3.431+05	4.647+04
4	1.440+09	3.784-01	4.251+10	3.536+02	1.526+00	2.749+00	2.125+09	1.404+09	3.537+05	5.359+04
5	1.800+09	3.723-01	4.870+10	3.656+02	1.562+00	2.792+00	2.857+09	1.744+09	3.626+05	5.989+04
6	2.160+09	3.670-01	5.449+10	3.776+02	1.593+00	2.831+00	3.590+09	2.085+09	3.704+05	6.560+04
7	2.520+09	3.622-01	6.019+10	3.892+02	1.610+00	2.869+00	4.167+09	2.433+09	3.782+05	7.097+04
8	2.880+09	3.580-01	6.540+10	4.014+02	1.635+00	2.902+00	4.900+09	2.774+09	3.846+05	7.584+04
9	3.240+09	3.541-01	7.096+10	4.138+02	1.656+00	2.933+00	5.605+09	3.116+09	3.906+05	8.044+04
10	3.600+09	3.505-01	7.534+10	4.262+02	1.675+00	2.963+00	6.308+09	3.457+09	3.962+05	8.479+04
11	3.960+09	3.472-01	8.008+10	4.389+02	1.692+00	2.991+00	7.012+09	3.799+09	4.015+05	8.893+04
12	4.320+09	3.440-01	8.471+10	4.515+02	1.708+00	3.018+00	7.707+09	4.142+09	4.066+05	9.290+04
13	4.680+09	3.411-01	8.921+10	4.645+02	1.723+00	3.044+00	8.410+09	4.484+09	4.114+05	9.670+04
14	5.040+09	3.384-01	9.361+10	4.776+02	1.737+00	3.069+00	9.112+09	4.826+09	4.160+05	1.003+05
15	5.400+09	3.359-01	9.770+10	4.925+02	1.747+00	3.091+00	9.781+09	5.169+09	4.203+05	1.037+05
16	5.760+09	3.333-01	1.021+11	5.063+02	1.763+00	3.116+00	1.052+10	5.509+09	4.246+05	1.073+05
17	6.120+09	3.311-01	1.061+11	5.195+02	1.771+00	3.137+00	1.118+10	5.854+09	4.286+05	1.104+05
18	6.480+09	3.288-01	1.102+11	5.334+02	1.782+00	3.159+00	1.188+10	6.196+09	4.326+05	1.136+05
19	6.840+09	3.267-01	1.142+11	5.473+02	1.793+00	3.180+00	1.258+10	6.538+09	4.364+05	1.167+05
20	7.200+09	3.246-01	1.182+11	5.613+02	1.803+00	3.200+00	1.328+10	6.880+09	4.401+05	1.197+05
21	7.560+09	3.226-01	1.221+11	5.755+02	1.813+00	3.220+00	1.398+10	7.222+09	4.437+05	1.227+05
22	7.920+09	3.207-01	1.260+11	5.896+02	1.821+00	3.240+00	1.466+10	7.565+09	4.473+05	1.256+05
23	8.280+09	3.188-01	1.299+11	6.040+02	1.831+00	3.259+00	1.536+10	7.907+09	4.507+05	1.285+05
24	8.640+09	3.170-01	1.337+11	6.186+02	1.839+00	3.278+00	1.607+10	8.249+09	4.541+05	1.313+05
25	9.000+09	3.153-01	1.374+11	6.332+02	1.848+00	3.296+00	1.677+10	8.591+09	4.574+05	1.340+05
26	9.360+09	3.136-01	1.411+11	6.481+02	1.856+00	3.314+00	1.748+10	8.933+09	4.606+05	1.366+05
27	9.720+09	3.120-01	1.448+11	6.630+02	1.864+00	3.331+00	1.819+10	9.274+09	4.637+05	1.392+05
28	1.008+10	3.105-01	1.484+11	6.780+02	1.872+00	3.348+00	1.890+10	9.616+09	4.668+05	1.418+05
29	1.044+10	3.089-01	1.520+11	6.932+02	1.879+00	3.365+00	1.961+10	9.957+09	4.698+05	1.443+05
30	1.080+10	3.075-01	1.556+11	7.085+02	1.887+00	3.381+00	2.033+10	1.030+10	4.728+05	1.468+05
31	1.116+10	3.060-01	1.592+11	7.239+02	1.894+00	3.397+00	2.104+10	1.064+10	4.757+05	1.492+05
32	1.152+10	3.046-01	1.627+11	7.394+02	1.900+00	3.413+00	2.175+10	1.098+10	4.785+05	1.516+05
33	1.188+10	3.033-01	1.662+11	7.550+02	1.907+00	3.429+00	2.247+10	1.132+10	4.813+05	1.540+05
34	1.224+10	3.019-01	1.697+11	7.708+02	1.914+00	3.444+00	2.319+10	1.166+10	4.841+05	1.563+05
35	1.260+10	3.006-01	1.731+11	7.866+02	1.920+00	3.460+00	2.391+10	1.200+10	4.868+05	1.586+05
36	1.296+10	2.994-01	1.765+11	8.025+02	1.926+00	3.474+00	2.463+10	1.235+10	4.894+05	1.608+05
37	1.332+10	2.981-01	1.799+11	8.186+02	1.932+00	3.489+00	2.535+10	1.269+10	4.921+05	1.631+05
38	1.368+10	2.969-01	1.833+11	3.347+02	1.938+00	3.504+00	2.607+10	1.303+10	4.947+05	1.653+05
39	1.404+10	2.958-01	1.867+11	8.509+02	1.944+00	3.518+00	2.680+10	1.337+10	4.972+05	1.674+05
40	1.440+10	2.946-01	1.900+11	8.672+02	1.950+00	3.532+00	2.753+10	1.371+10	4.997+05	1.696+05
41	1.476+10	2.935-01	1.933+11	8.837+02	1.955+00	3.546+00	2.825+10	1.405+10	5.022+05	1.717+05
42	1.512+10	2.924-01	1.967+11	9.002+02	1.960+00	3.560+00	2.898+10	1.439+10	5.047+05	1.738+05
43	1.548+10	2.913-01	1.999+11	9.168+02	1.966+00	3.573+00	2.971+10	1.473+10	5.071+05	1.758+05
44	1.584+10	2.903-01	2.032+11	9.335+02	1.971+00	3.586+00	3.044+10	1.507+10	5.095+05	1.779+05
45	1.620+10	2.892-01	2.065+11	9.502+02	1.976+00	3.600+00	3.118+10	1.541+10	5.118+05	1.799+05
46	1.656+10	2.882-01	2.097+11	9.671+02	1.981+00	3.613+00	3.191+10	1.575+10	5.142+05	1.819+05
47	1.692+10	2.872-01	2.129+11	9.841+02	1.986+00	3.626+00	3.265+10	1.609+10	5.165+05	1.838+05
48	1.728+10	2.862-01	2.161+11	1.001+03	1.991+00	3.638+00	3.339+10	1.643+10	5.188+05	1.858+05
49	1.764+10	2.853-01	2.193+11	1.018+03	1.996+00	3.651+00	3.412+10	1.677+10	5.210+05	1.877+05

TABLE B.3 (Continued)

5 Percent Water (Continued)

50	1.800+10	2.672-01	2.416+11	9.344+02	9.982-01	3.742+00	1.800+10	1.800+10	5.299+05	1.900+05
51	1.836+10	2.663-01	2.450+11	1.007+03	9.982-01	3.755+00	1.836+10	1.836+10	5.318+05	1.919+05
52	1.872+10	2.654-01	2.484+11	1.024+03	9.982-01	3.766+00	1.872+10	1.872+10	5.339+05	1.938+05
53	1.908+10	2.645-01	2.517+11	1.042+03	9.982-01	3.780+00	1.906+10	1.908+10	5.360+05	1.957+05
54	1.944+10	2.637-01	2.551+11	1.061+03	9.982-01	3.793+00	1.944+10	1.944+10	5.380+05	1.975+05
55	1.980+10	2.628-01	2.584+11	1.079+03	9.982-01	3.805+00	1.980+10	1.980+10	5.400+05	1.994+05
56	2.016+10	2.620-01	2.617+11	1.097+03	9.982-01	3.817+00	2.016+10	2.016+10	5.420+05	2.012+05
57	2.052+10	2.612-01	2.650+11	1.116+03	9.982-01	3.829+00	2.052+10	2.052+10	5.440+05	2.030+05
58	2.088+10	2.604-01	2.683+11	1.134+03	9.982-01	3.841+00	2.088+10	2.088+1	5.459+05	2.048+05
59	2.124+10	2.596-01	2.716+11	1.153+03	9.982-01	3.852+00	2.124+10	2.124+1	5.479+05	2.065+05
60	2.160+10	2.588-01	2.749+11	1.172+03	9.982-01	3.864+00	2.160+10	2.160+10	5.498+05	2.083+05
61	2.196+10	2.580-01	2.781+11	1.191+03	9.982-01	3.875+00	2.196+10	2.196+10	5.517+05	2.100+05
62	2.232+10	2.573-01	2.813+11	1.210+03	9.982-01	3.887+00	2.232+10	2.232+10	5.536+05	2.118+05
63	2.268+10	2.565-01	2.846+11	1.229+03	9.982-01	3.898+00	2.268+10	2.268+10	5.555+05	2.135+05
64	2.304+10	2.558-01	2.878+11	1.248+03	9.982-01	3.909+00	2.304+10	2.304+10	5.573+05	2.152+05
65	2.340+10	2.551-01	2.910+11	1.268+03	9.982-01	3.920+00	2.340+10	2.340+10	5.592+05	2.168+05
66	2.376+10	2.544-01	2.942+11	1.287+03	9.982-01	3.931+00	2.376+10	2.376+10	5.610+05	2.185+05
67	2.412+10	2.537-01	2.974+11	1.307+03	9.982-01	3.942+00	2.412+10	2.412+10	5.628+05	2.202+05
68	2.448+10	2.530-01	3.005+11	1.326+03	9.982-01	3.953+00	2.448+10	2.448+10	5.646+05	2.218+05

TABLE B.3 (Continued)

10 PERCENT WATER (M_W = .10)

K	AIX	TVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	4.302-01	1.603+10	3.221+02	1.308+00	2.544+00	2.114+08	3.765+08	2.836+05	2.685+04
2	7.200+08	4.164-01	2.446+10	3.389+02	1.391+00	2.613+00	8.955+08	7.005+08	3.064+05	3.793+04
3	1.080+09	4.067-01	3.146+10	3.538+02	1.446+00	2.667+00	1.601+09	1.022+09	3.220+05	4.643+04
4	1.440+09	3.990-01	3.790+10	3.676+02	1.482+00	2.715+00	2.258+09	1.349+09	3.352+05	5.373+04
5	1.800+09	3.926-01	4.361+10	3.815+02	1.515+00	2.755+00	2.949+09	1.672+09	3.454+05	5.999+04
6	2.160+09	3.871-01	4.895+10	3.952+02	1.545+00	2.792+00	3.652+09	1.994+09	3.542+05	6.568+04
7	2.520+09	3.823-01	5.398+10	4.092+02	1.567+00	2.826+00	4.327+09	2.319+09	3.622+05	7.082+04
8	2.880+09	3.776-01	5.897+10	4.220+02	1.593+00	2.859+00	5.032+09	2.641+09	3.694+05	7.585+04
9	3.240+09	3.735-01	6.368+10	4.354+02	1.613+00	2.889+00	5.720+09	2.964+09	3.761+05	8.045+04
10	3.600+09	3.698-01	6.823+10	4.489+02	1.632+00	2.917+00	6.409+09	3.288+09	3.823+05	8.481+04
11	3.960+09	3.663-01	7.264+10	4.624+02	1.649+00	2.944+00	7.098+09	3.611+09	3.881+05	8.894+04
12	4.320+09	3.632-01	7.681+10	4.769+02	1.662+00	2.970+00	7.765+09	3.937+09	3.936+05	9.273+04
13	4.680+09	3.602-01	8.101+10	4.907+02	1.677+00	2.994+00	8.447+09	4.261+09	3.989+05	9.651+04
14	5.040+09	3.573-01	8.513+10	5.044+02	1.691+00	3.018+00	9.128+09	4.586+09	4.039+05	1.002+05
15	5.400+09	3.546-01	8.918+10	5.182+02	1.709+00	3.041+00	9.809+09	4.910+09	4.087+05	1.037+05
16	5.760+09	3.520-01	9.316+10	5.320+02	1.717+00	3.064+00	1.049+10	5.234+09	4.133+05	1.071+05
17	6.120+09	3.495-01	9.707+10	5.460+02	1.729+00	3.085+00	1.117+10	5.559+09	4.177+05	1.104+05
18	6.480+09	3.472-01	1.009+11	5.600+02	1.740+00	3.106+00	1.185+10	5.883+09	4.219+05	1.136+05
19	6.840+09	3.449-01	1.047+11	5.741+02	1.751+00	3.127+00	1.253+10	6.207+09	4.261+05	1.168+05
20	7.200+09	3.428-01	1.084+11	5.883+02	1.761+00	3.147+00	1.321+10	6.532+09	4.301+05	1.198+05
21	7.560+09	3.407-01	1.121+11	6.026+02	1.771+00	3.166+00	1.390+10	6.856+09	4.340+05	1.228+05
22	7.920+09	3.387-01	1.158+11	6.170+02	1.781+00	3.185+00	1.456+10	7.180+09	4.377+05	1.257+05
23	8.280+09	3.368-01	1.194+11	6.315+02	1.790+00	3.203+00	1.526+10	7.504+09	4.414+05	1.285+05
24	8.640+09	3.350-01	1.230+11	6.461+02	1.799+00	3.221+00	1.595+10	7.828+09	4.450+05	1.313+05
25	9.000+09	3.332-01	1.265+11	6.607+02	1.807+00	3.239+00	1.663+10	8.152+09	4.485+05	1.340+05
26	9.360+09	3.315-01	1.300+11	6.755+02	1.816+00	3.256+00	1.731+10	8.476+09	4.519+05	1.367+05
27	9.720+09	3.298-01	1.334+11	6.903+02	1.824+00	3.273+00	1.800+10	8.800+09	4.552+05	1.393+05
28	1.008+10	3.282-01	1.369+11	7.052+02	1.831+00	3.290+00	1.868+10	9.124+09	4.585+05	1.419+05
29	1.044+10	3.266-01	1.403+11	7.202+02	1.839+00	3.306+00	1.937+10	9.448+09	4.617+05	1.444+05
30	1.080+10	3.251-01	1.436+11	7.353+02	1.846+00	3.322+00	2.006+10	9.771+09	4.648+05	1.468+05
31	1.116+10	3.236-01	1.470+11	7.505+02	1.853+00	3.338+00	2.075+10	1.009+10	4.679+05	1.493+05
32	1.152+10	3.221-01	1.503+11	7.657+02	1.860+00	3.353+00	2.143+10	1.042+10	4.709+05	1.517+05
33	1.188+10	3.207-01	1.536+11	7.810+02	1.867+00	3.369+00	2.212+10	1.074+10	4.739+05	1.540+05
34	1.224+10	3.194-01	1.569+11	7.964+02	1.874+00	3.384+00	2.281+10	1.107+10	4.768+05	1.564+05
35	1.260+10	3.180-01	1.601+11	8.119+02	1.880+00	3.398+00	2.351+10	1.139+10	4.797+05	1.586+05
36	1.296+10	3.167-01	1.634+11	8.274+02	1.886+00	3.413+00	2.420+10	1.171+10	4.825+05	1.609+05
37	1.332+10	3.154-01	1.666+11	8.430+02	1.892+00	3.427+00	2.489+10	1.203+10	4.853+05	1.631+05
38	1.368+10	3.142-01	1.698+11	8.587+02	1.898+00	3.441+00	2.558+10	1.236+10	4.880+05	1.653+05
39	1.404+10	3.130-01	1.729+11	8.745+02	1.904+00	3.455+00	2.628+10	1.268+10	4.907+05	1.675+05
40	1.440+10	3.118-01	1.761+11	8.903+02	1.910+00	3.469+00	2.697+10	1.300+10	4.933+05	1.696+05
41	1.476+10	3.106-01	1.792+11	9.062+02	1.915+00	3.482+00	2.767+10	1.333+10	4.959+05	1.717+05
42	1.512+10	3.095-01	1.823+11	9.222+02	1.921+00	3.496+00	2.837+10	1.365+10	4.985+05	1.738+05
43	1.548+10	3.084-01	1.855+11	9.382+02	1.926+00	3.509+00	2.906+10	1.397+10	5.011+05	1.759+05
44	1.584+10	3.073-01	1.885+11	9.543+02	1.932+00	3.522+00	2.976+10	1.429+10	5.036+05	1.779+05
45	1.620+10	3.062-01	1.916+11	9.704+02	1.937+00	3.535+00	3.046+10	1.462+10	5.061+05	1.799+05
46	1.656+10	3.052-01	1.947+11	9.867+02	1.942+00	3.548+00	3.116+10	1.494+10	5.085+05	1.819+05
47	1.692+10	3.042-01	1.977+11	1.003+03	1.947+00	3.560+00	3.187+10	1.526+10	5.109+05	1.839+05
48	1.728+10	3.032-01	2.007+11	1.019+03	1.952+00	3.573+00	3.257+10	1.558+10	5.133+05	1.858+05
49	1.764+10	3.022-01	2.038+11	1.036+03	1.957+00	3.585+00	3.327+10	1.590+10	5.157+05	1.878+05

TABLE B.3 (Continued)

10 Percent Water (Continued)

50	1.800+10	2.843-01	2.225+11	1.035+03	2.000+00	3.663+00	3.486+10	1.711+10	5.232+05	1.896+05
51	1.836+10	2.834-01	2.257+11	1.053+03	2.005+00	3.676+00	3.561+10	1.745+10	5.254+05	1.915+05
52	1.872+10	2.825-01	2.288+11	1.070+03	2.009+00	3.688+00	3.635+10	1.779+10	5.276+05	1.934+05
53	1.908+10	2.816-01	2.319+11	1.087+03	2.014+00	3.700+00	3.709+10	1.813+10	5.298+05	1.952+05
54	1.944+10	2.807-01	2.351+11	1.105+03	2.018+00	3.712+00	3.784+10	1.847+10	5.319+05	1.971+05
55	1.980+10	2.798-01	2.382+11	1.123+03	2.023+00	3.724+00	3.858+10	1.881+10	5.340+05	1.989+05
56	2.016+10	2.790-01	2.413+11	1.140+03	2.027+00	3.735+00	3.933+10	1.915+10	5.361+05	2.007+05
57	2.052+10	2.782-01	2.444+11	1.158+03	2.031+00	3.747+00	4.008+10	1.949+10	5.382+05	2.025+05
58	2.088+10	2.773-01	2.474+11	1.176+03	2.035+00	3.758+00	4.083+10	1.983+10	5.402+05	2.042+05
59	2.124+10	2.765-01	2.505+11	1.194+03	2.039+00	3.770+00	4.159+10	2.017+10	5.423+05	2.060+05
60	2.160+10	2.757-01	2.536+11	1.212+03	2.043+00	3.781+00	4.234+10	2.051+10	5.443+05	2.077+05
61	2.196+10	2.749-01	2.566+11	1.230+03	2.047+00	3.792+00	4.309+10	2.085+10	5.463+05	2.095+05
62	2.232+10	2.742-01	2.597+11	1.248+03	2.051+00	3.803+00	4.385+10	2.119+10	5.483+05	2.112+05
63	2.268+10	2.734-01	2.627+11	1.266+03	2.055+00	3.814+00	4.461+10	2.153+10	5.502+05	2.129+05
64	2.304+10	2.727-01	2.657+11	1.284+03	2.059+00	3.825+00	4.537+10	2.186+10	5.522+05	2.146+05
65	2.340+10	2.719-01	2.687+11	1.302+03	2.063+00	3.836+00	4.613+10	2.220+10	5.541+05	2.162+05
66	2.376+10	2.712-01	2.717+11	1.321+03	2.066+00	3.846+00	4.689+10	2.254+10	5.560+05	2.179+05
67	2.412+10	2.705-01	2.747+11	1.339+03	2.070+00	3.857+00	4.765+10	2.288+10	5.579+05	2.195+05
68	2.448+10	2.698-01	2.777+11	1.358+03	2.074+00	3.867+00	4.842+10	2.322+10	5.598+05	2.212+05
69	2.484+10	2.690-01	2.806+11	1.376+03	2.077+00	3.878+00	4.918+10	2.356+10	5.617+05	2.228+05
70	2.520+10	2.684-01	2.836+11	1.395+03	2.081+00	3.888+00	4.995+10	2.390+10	5.636+05	2.244+05
71	2.556+10	2.677-01	2.866+11	1.414+03	2.084+00	3.898+00	5.072+10	2.424+10	5.654+05	2.260+05
72	2.592+10	2.670-01	2.895+11	1.433+03	2.088+00	3.909+00	5.149+10	2.457+10	5.672+05	2.276+05
73	2.628+10	2.663-01	2.924+11	1.451+03	2.091+00	3.919+00	5.226+10	2.491+10	5.690+05	2.292+05
74	2.664+10	2.657-01	2.954+11	1.470+03	2.094+00	3.929+00	5.303+10	2.525+10	5.708+05	2.307+05
75	2.700+10	2.650-01	2.983+11	1.489+03	2.098+00	3.939+00	5.381+10	2.559+10	5.726+05	2.323+05
76	2.736+10	2.644-01	3.012+11	1.508+03	2.101+00	3.949+00	5.459+10	2.593+10	5.744+05	2.338+05

TABLE B.3 (Continued)

15 PERCENT WATER (M_W = .15)

K	AIX	TVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	4.532-01	1.905+10	3.253+02	1.284+00	2.527+00	3.109+08	3.687+08	2.641+05	2.683+04
2	7.200+08	4.382-01	2.170+10	3.438+02	1.363+00	2.590+00	9.893+08	6.724+08	2.887+05	3.791+04
3	1.080+09	4.278-01	2.814+10	3.602+02	1.417+00	2.640+00	1.681+09	9.739+08	3.057+05	4.644+04
4	1.440+09	4.200-01	3.407+10	3.755+02	1.450+00	2.686+00	2.328+09	1.283+09	3.203+05	5.365+04
5	1.800+09	4.132-01	3.940+10	3.904+02	1.482+00	2.725+00	3.002+09	1.588+09	3.315+05	5.995+04
6	2.160+09	4.073-01	4.442+10	4.049+02	1.511+00	2.760+00	3.681+09	1.892+09	3.410+05	6.570+04
7	2.520+09	4.020-01	4.918+10	4.191+02	1.536+00	2.793+00	4.353+09	2.197+09	3.496+05	7.096+04
8	2.880+09	3.974-01	5.374+10	4.333+02	1.558+00	2.823+00	5.024+09	2.502+09	3.574+05	7.586+04
9	3.240+09	3.931-01	5.814+10	4.474+02	1.578+00	2.852+00	5.693+09	2.807+09	3.645+05	8.046+04
10	3.600+09	3.899-01	6.227+10	4.621+02	1.594+00	2.878+00	6.358+09	3.113+09	3.711+05	8.464+04
11	3.960+09	3.856-01	6.653+10	4.754+02	1.613+00	2.905+00	7.029+09	3.418+09	3.774+05	8.694+04
12	4.320+09	3.823-01	7.047+10	4.900+02	1.627+00	2.930+00	7.685+09	3.726+09	3.832+05	9.276+04
13	4.680+09	3.792-01	7.441+10	5.041+02	1.642+00	2.953+00	8.347+09	4.033+09	3.888+05	9.654+04
14	5.040+09	3.762-01	7.828+10	5.181+02	1.656+00	2.977+00	9.008+09	4.340+09	3.941+05	1.002+05
15	5.400+09	3.733-01	8.208+10	5.321+02	1.669+00	2.999+00	9.669+09	4.647+09	3.991+05	1.037+05
16	5.760+09	3.706-01	8.582+10	5.462+02	1.681+00	3.020+00	1.033+10	4.954+09	4.040+05	1.072+05
17	6.120+09	3.681-01	8.949+10	5.602+02	1.693+00	3.041+00	1.099+10	5.261+09	4.087+05	1.105+05
18	6.480+09	3.657-01	9.311+10	5.744+02	1.704+00	3.062+00	1.165+10	5.568+09	4.132+05	1.137+05
19	6.840+09	3.633-01	9.668+10	5.886+02	1.715+00	3.081+00	1.231+10	5.875+09	4.175+05	1.168+05
20	7.200+09	3.611-01	1.002+11	6.028+02	1.725+00	3.101+00	1.297+10	6.183+09	4.217+05	1.199+05
21	7.560+09	3.589-01	1.037+11	6.171+02	1.735+00	3.119+00	1.362+10	6.490+09	4.258+05	1.228+05
22	7.920+09	3.569-01	1.071+11	6.314+02	1.745+00	3.136+00	1.428+10	6.797+09	4.298+05	1.257+05
23	8.280+09	3.549-01	1.105+11	6.458+02	1.754+00	3.155+00	1.494+10	7.104+09	4.336+05	1.286+05
24	8.640+09	3.530-01	1.139+11	6.603+02	1.763+00	3.173+00	1.560+10	7.412+09	4.374+05	1.313+05
25	9.000+09	3.511-01	1.172+11	6.748+02	1.771+00	3.190+00	1.626+10	7.719+09	4.411+05	1.340+05
26	9.360+09	3.493-01	1.205+11	6.894+02	1.780+00	3.207+00	1.692+10	8.026+09	4.446+05	1.367+05
27	9.720+09	3.476-01	1.238+11	7.040+02	1.788+00	3.223+00	1.758+10	8.333+09	4.481+05	1.393+05
28	1.008+10	3.459-01	1.270+11	7.187+02	1.796+00	3.239+00	1.824+10	8.640+09	4.516+05	1.419+05
29	1.044+10	3.443-01	1.302+11	7.334+02	1.803+00	3.255+00	1.890+10	8.947+09	4.549+05	1.444+05
30	1.080+10	3.427-01	1.334+11	7.482+02	1.810+00	3.271+00	1.956+10	9.254+09	4.582+05	1.469+05
31	1.116+10	3.412-01	1.366+11	7.630+02	1.818+00	3.286+00	2.022+10	9.561+09	4.614+05	1.493+05
32	1.152+10	3.397-01	1.397+11	7.779+02	1.825+00	3.301+00	2.088+10	9.867+09	4.645+05	1.517+05
33	1.188+10	3.383-01	1.428+11	7.929+02	1.831+00	3.316+00	2.155+10	1.017+10	4.676+05	1.541+05
34	1.224+10	3.366-01	1.459+11	8.079+02	1.838+00	3.330+00	2.221+10	1.048+10	4.707+05	1.564+05
35	1.260+10	3.355-01	1.490+11	8.230+02	1.844+00	3.345+00	2.287+10	1.079+10	4.737+05	1.587+05
36	1.296+10	3.341-01	1.520+11	8.381+02	1.851+00	3.359+00	2.354+10	1.109+10	4.766+05	1.609+05
37	1.332+10	3.328-01	1.551+11	8.533+02	1.857+00	3.373+00	2.420+10	1.140+10	4.795+05	1.632+05
38	1.368+10	3.315-01	1.581+11	8.685+02	1.863+00	3.387+00	2.486+10	1.171+10	4.823+05	1.653+05
39	1.404+10	3.303-01	1.611+11	8.838+02	1.869+00	3.400+00	2.553+10	1.201+10	4.852+05	1.675+05
40	1.440+10	3.290-01	1.641+11	8.991+02	1.874+00	3.413+00	2.619+10	1.232+10	4.879+05	1.696+05
41	1.476+10	3.278-01	1.671+11	9.145+02	1.880+00	3.427+00	2.686+10	1.262+10	4.906+05	1.718+05
42	1.512+10	3.267-01	1.700+11	9.299+02	1.886+00	3.440+00	2.753+10	1.293+10	4.933+05	1.738+05
43	1.548+10	3.255-01	1.729+11	9.454+02	1.891+00	3.452+00	2.819+10	1.324+10	4.960+05	1.759+05
44	1.584+10	3.244-01	1.759+11	9.610+02	1.896+00	3.465+00	2.886+10	1.354+10	4.986+05	1.779+05
45	1.620+10	3.233-01	1.788+11	9.765+02	1.902+00	3.476+00	2.953+10	1.385+10	5.011+05	1.800+05
46	1.656+10	3.222-01	1.817+11	9.922+02	1.907+00	3.490+00	3.020+10	1.415+10	5.037+05	1.819+05
47	1.692+10	3.212-01	1.846+11	1.008+03	1.912+00	3.502+00	3.087+10	1.446+10	5.062+05	1.839+05
48	1.728+10	3.201-01	1.874+11	1.024+03	1.917+00	3.514+00	3.154+10	1.476+10	5.087+05	1.859+05
49	1.764+10	3.191-01	1.903+11	1.039+03	1.921+00	3.526+00	3.221+10	1.507+10	5.111+05	1.878+05

TABLE B.3 (Continued)

15 Percent Water (Continued)

50	1.800+10	3.012-01	2.068+11	1.052+03	1.961+00	3.597+00	3.398+10	1.622+10	5.180+05	1.897+05
51	1.836+10	3.002-01	2.098+11	1.069+03	1.966+00	3.609+00	3.468+10	1.655+10	5.203+05	1.916+05
52	1.872+10	2.993-01	2.127+11	1.085+03	1.971+00	3.621+00	3.539+10	1.687+10	5.226+05	1.934+05
53	1.908+10	2.984-01	2.157+11	1.102+03	1.975+00	3.633+00	3.609+10	1.719+10	5.249+05	1.953+05
54	1.944+10	2.975-01	2.187+11	1.119+03	1.979+00	3.644+00	3.680+10	1.751+10	5.271+05	1.971+05
55	1.980+10	2.966-01	2.216+11	1.135+03	1.984+00	3.656+00	3.751+10	1.783+10	5.293+05	1.989+05
56	2.016+10	2.957-01	2.245+11	1.152+03	1.988+00	3.667+00	3.822+10	1.815+10	5.315+05	2.007+05
57	2.052+10	2.949-01	2.275+11	1.169+03	1.992+00	3.679+00	3.893+10	1.847+10	5.337+05	2.025+05
58	2.088+10	2.940-01	2.304+11	1.186+03	1.997+00	3.690+00	3.964+10	1.880+10	5.358+05	2.043+05
59	2.124+10	2.932-01	2.333+11	1.203+03	2.001+00	3.701+00	4.036+10	1.912+10	5.379+05	2.061+05
60	2.160+10	2.923-01	2.362+11	1.220+03	2.005+00	3.712+00	4.107+10	1.944+10	5.400+05	2.078+05
61	2.196+10	2.915-01	2.390+11	1.237+03	2.009+00	3.723+00	4.178+10	1.976+10	5.421+05	2.095+05
62	2.232+10	2.907-01	2.419+11	1.254+03	2.013+00	3.734+00	4.250+10	2.008+10	5.442+05	2.112+05
63	2.268+10	2.900-01	2.446+11	1.272+03	2.017+00	3.744+00	4.322+10	2.040+10	5.463+05	2.129+05
64	2.304+10	2.892-01	2.476+11	1.289+03	2.021+00	3.755+00	4.393+10	2.072+10	5.483+05	2.146+05
65	2.340+10	2.884-01	2.505+11	1.306+03	2.024+00	3.765+00	4.465+10	2.104+10	5.503+05	2.163+05
66	2.376+10	2.877-01	2.533+11	1.324+03	2.028+00	3.776+00	4.537+10	2.136+10	5.523+05	2.179+05
67	2.412+10	2.869-01	2.561+11	1.341+03	2.032+00	3.786+00	4.609+10	2.168+10	5.543+05	2.196+05
68	2.448+10	2.862-01	2.590+11	1.358+03	2.035+00	3.796+00	4.681+10	2.200+10	5.562+05	2.212+05
69	2.484+10	2.855-01	2.618+11	1.376+03	2.039+00	3.807+00	4.753+10	2.232+10	5.582+05	2.228+05
70	2.520+10	2.848-01	2.646+11	1.394+03	2.043+00	3.817+00	4.826+10	2.264+10	5.601+05	2.245+05
71	2.556+10	2.841-01	2.674+11	1.411+03	2.046+00	3.827+00	4.898+10	2.296+10	5.620+05	2.261+05
72	2.592+10	2.834-01	2.702+11	1.429+03	2.050+00	3.837+00	4.970+10	2.328+10	5.639+05	2.276+05
73	2.628+10	2.827-01	2.730+11	1.447+03	2.053+00	3.847+00	5.043+10	2.360+10	5.658+05	2.292+05
74	2.664+10	2.820-01	2.757+11	1.464+03	2.057+00	3.856+00	5.116+10	2.392+10	5.677+05	2.308+05
75	2.700+10	2.813-01	2.785+11	1.482+03	2.060+00	3.866+00	5.188+10	2.424+10	5.696+05	2.323+05
76	2.736+10	2.807-01	2.813+11	1.500+03	2.063+00	3.876+00	5.261+10	2.455+10	5.714+05	2.339+05
77	2.772+10	2.800-01	2.840+11	1.518+03	2.067+00	3.885+00	5.334+10	2.487+10	5.732+05	2.354+05
78	2.808+10	2.794-01	2.868+11	1.536+03	2.070+00	3.895+00	5.407+10	2.519+10	5.751+05	2.369+05
79	2.844+10	2.788-01	2.895+11	1.554+03	2.073+00	3.904+00	5.480+10	2.551+10	5.769+05	2.385+05
80	2.880+10	2.781-01	2.922+11	1.572+03	2.076+00	3.914+00	5.554+10	2.583+10	5.787+05	2.400+05
81	2.916+10	2.775-01	2.950+11	1.590+03	2.080+00	3.923+00	5.627+10	2.615+10	5.804+05	2.415+05
82	2.952+10	2.769-01	2.977+11	1.608+03	2.083+00	3.932+00	5.700+10	2.647+10	5.822+05	2.430+05
83	2.988+10	2.763-01	3.004+11	1.626+03	2.086+00	3.941+00	5.774+10	2.678+10	5.840+05	2.444+05

TABLE B.3 (Continued)

20 PERCENT WATER (M_W = .20)

K	AIX	TVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	4.764-01	1.255+10	3.268+02	1.265+00	2.514+00	3.665+08	3.584+08	2.497+05	2.683+04
2	7.200+08	4.602-01	1.953+10	3.462+02	1.341+00	2.572+00	1.029+09	6.428+08	2.752+05	3.787+04
3	1.080+09	4.492-01	2.551+10	3.633+02	1.391+00	2.619+00	1.696+09	9.261+08	2.932+05	4.644+04
4	1.440+09	4.408-01	3.114+10	3.790+02	1.425+00	2.663+00	2.326+09	1.218+09	3.089+05	5.379+04
5	1.800+09	4.337-01	3.600+10	3.947+02	1.456+00	2.699+00	2.987+09	1.503+09	3.203+05	5.999+04
6	2.160+09	4.276-01	4.069+10	4.097+02	1.483+00	2.733+00	3.639+09	1.790+09	3.305+05	6.571+04
7	2.520+09	4.221-01	4.514+10	4.244+02	1.507+00	2.764+00	4.290+09	2.078+09	3.395+05	7.097+04
8	2.880+09	4.172-01	4.942+10	4.389+02	1.529+00	2.793+00	4.938+09	2.366+09	3.476+05	7.587+04
9	3.240+09	4.130-01	5.342+10	4.538+02	1.547+00	2.820+00	5.586+09	2.654+09	3.550+05	8.031+04
10	3.600+09	4.089-01	5.742+10	4.681+02	1.565+00	2.846+00	6.230+09	2.943+09	3.620+05	8.465+04
11	3.960+09	4.051-01	6.132+10	4.823+02	1.581+00	2.871+00	6.872+09	3.232+09	3.685+05	8.880+04
12	4.320+09	4.016-01	6.512+10	4.965+02	1.597+00	2.895+00	7.512+09	3.522+09	3.747+05	9.276+04
13	4.680+09	3.982-01	6.884+10	5.106+02	1.611+00	2.918+00	8.152+09	3.812+09	3.805+05	9.656+04
14	5.040+09	3.951-01	7.249+10	5.247+02	1.625+00	2.941+00	8.790+09	4.103+09	3.860+05	1.002+05
15	5.400+09	3.922-01	7.607+10	5.387+02	1.638+00	2.962+00	9.428+09	4.393+09	3.913+05	1.038+05
16	5.760+09	3.894-01	7.959+10	5.528+02	1.650+00	2.983+00	1.006+10	4.684+09	3.964+05	1.072+05
17	6.120+09	3.867-01	8.306+10	5.669+02	1.662+00	3.003+00	1.070+10	4.975+09	4.012+05	1.105+05
18	6.480+09	3.842-01	8.647+10	5.810+02	1.673+00	3.023+00	1.134+10	5.266+09	4.059+05	1.137+05
19	6.840+09	3.818-01	8.984+10	5.951+02	1.684+00	3.042+00	1.197+10	5.557+09	4.104+05	1.168+05
20	7.200+09	3.795-01	9.317+10	6.093+02	1.694+00	3.060+00	1.261+10	5.848+09	4.148+05	1.199+05
21	7.560+09	3.773-01	9.645+10	6.234+02	1.704+00	3.078+00	1.324+10	6.139+09	4.191+05	1.228+05
22	7.920+09	3.751-01	9.970+10	6.376+02	1.713+00	3.096+00	1.388+10	6.431+09	4.232+05	1.257+05
23	8.280+09	3.731-01	1.029+11	6.518+02	1.722+00	3.113+00	1.451+10	6.722+09	4.272+05	1.286+05
24	8.640+09	3.711-01	1.061+11	6.661+02	1.731+00	3.130+00	1.515+10	7.014+09	4.311+05	1.313+05
25	9.000+09	3.692-01	1.092+11	6.804+02	1.740+00	3.147+00	1.578+10	7.305+09	4.349+05	1.341+05
26	9.360+09	3.673-01	1.124+11	6.947+02	1.748+00	3.163+00	1.641+10	7.596+09	4.386+05	1.367+05
27	9.720+09	3.655-01	1.154+11	7.091+02	1.756+00	3.179+00	1.705+10	7.888+09	4.422+05	1.393+05
28	1.008+10	3.638-01	1.185+11	7.234+02	1.764+00	3.195+00	1.768+10	8.179+09	4.457+05	1.419+05
29	1.044+10	3.621-01	1.216+11	7.379+02	1.771+00	3.210+00	1.832+10	8.471+09	4.492+05	1.444+05
30	1.080+10	3.605-01	1.246+11	7.523+02	1.779+00	3.225+00	1.895+10	8.762+09	4.526+05	1.469+05
31	1.116+10	3.589-01	1.276+11	7.669+02	1.786+00	3.240+00	1.959+10	9.053+09	4.559+05	1.493+05
32	1.152+10	3.574-01	1.305+11	7.814+02	1.793+00	3.255+00	2.022+10	9.344+09	4.592+05	1.517+05
33	1.188+10	3.559-01	1.335+11	7.960+02	1.799+00	3.269+00	2.086+10	9.636+09	4.624+05	1.541+05
34	1.224+10	3.544-01	1.364+11	8.106+02	1.806+00	3.283+00	2.149+10	9.927+09	4.655+05	1.564+05
35	1.260+10	3.530-01	1.393+11	8.253+02	1.812+00	3.297+00	2.213+10	1.022+10	4.686+05	1.587+05
36	1.296+10	3.516-01	1.422+11	8.400+02	1.819+00	3.311+00	2.276+10	1.051+10	4.717+05	1.609+05
37	1.332+10	3.502-01	1.451+11	8.547+02	1.825+00	3.325+00	2.340+10	1.080+10	4.746+05	1.632+05
38	1.368+10	3.489-01	1.480+11	8.695+02	1.831+00	3.338+00	2.404+10	1.109+10	4.776+05	1.654+05
39	1.404+10	3.476-01	1.508+11	8.843+02	1.837+00	3.351+00	2.467+10	1.138+10	4.805+05	1.675+05
40	1.440+10	3.463-01	1.537+11	8.991+02	1.843+00	3.364+00	2.531+10	1.167+10	4.833+05	1.697+05
41	1.476+10	3.451-01	1.565+11	9.140+02	1.848+00	3.377+00	2.595+10	1.196+10	4.861+05	1.718+05
42	1.512+10	3.439-01	1.593+11	9.289+02	1.854+00	3.390+00	2.659+10	1.225+10	4.889+05	1.739+05
43	1.548+10	3.427-01	1.621+11	9.439+02	1.859+00	3.402+00	2.722+10	1.254+10	4.916+05	1.759+05
44	1.584+10	3.416-01	1.648+11	9.589+02	1.864+00	3.415+00	2.786+10	1.283+10	4.943+05	1.780+05
45	1.620+10	3.404-01	1.676+11	9.739+02	1.870+00	3.427+00	2.850+10	1.312+10	4.970+05	1.800+05
46	1.656+10	3.393-01	1.703+11	9.890+02	1.875+00	3.439+00	2.914+10	1.341+10	4.996+05	1.820+05
47	1.692+10	3.382-01	1.731+11	1.004+03	1.880+00	3.451+00	2.978+10	1.370+10	5.022+05	1.839+05
48	1.728+10	3.372-01	1.758+11	1.019+03	1.885+00	3.463+00	3.042+10	1.399+10	5.048+05	1.859+05
49	1.764+10	3.361-01	1.785+11	1.034+03	1.890+00	3.474+00	3.106+10	1.428+10	5.073+05	1.878+05

TABLE B.3 (Continued)

20 Percent Water (Continued)

50	1.800+10	3.181-01	1.931+11	1.055+03	1.926+00	3.538+00	3.288+10	1.537+10	5.136+05	1.897+05
51	1.836+10	3.171-01	1.960+11	1.071+03	1.931+00	3.550+00	3.355+10	1.568+10	5.160+05	1.916+05
52	1.872+10	3.162-01	1.988+11	1.087+03	1.936+00	3.562+00	3.423+10	1.598+10	5.183+05	1.935+05
53	1.908+10	3.152-01	2.016+11	1.103+03	1.940+00	3.573+00	3.490+10	1.629+10	5.207+05	1.953+05
54	1.944+10	3.143-01	2.044+11	1.119+03	1.945+00	3.584+00	3.557+10	1.659+10	5.230+05	1.972+05
55	1.980+10	3.134-01	2.072+11	1.135+03	1.949+00	3.596+00	3.625+10	1.690+10	5.253+05	1.990+05
56	2.016+10	3.125-01	2.100+11	1.151+03	1.953+00	3.607+00	3.692+10	1.720+10	5.275+05	2.008+05
57	2.052+10	3.116-01	2.127+11	1.167+03	1.958+00	3.618+00	3.760+10	1.751+10	5.298+05	2.026+05
58	2.088+10	3.107-01	2.155+11	1.183+03	1.962+00	3.629+00	3.827+10	1.781+10	5.320+05	2.043+05
59	2.124+10	3.098-01	2.183+11	1.200+03	1.966+00	3.640+00	3.895+10	1.811+10	5.342+05	2.061+05
60	2.160+10	3.090-01	2.210+11	1.216+03	1.970+00	3.650+00	3.963+10	1.842+10	5.364+05	2.078+05
61	2.196+10	3.082-01	2.237+11	1.232+03	1.974+00	3.661+00	4.031+10	1.872+10	5.386+05	2.096+05
62	2.232+10	3.073-01	2.265+11	1.248+03	1.978+00	3.672+00	4.098+10	1.903+10	5.407+05	2.113+05
63	2.268+10	3.065-01	2.292+11	1.265+03	1.982+00	3.682+00	4.166+10	1.933+10	5.428+05	2.130+05
64	2.304+10	3.057-01	2.319+11	1.281+03	1.986+00	3.692+00	4.234+10	1.963+10	5.449+05	2.147+05
65	2.340+10	3.049-01	2.346+11	1.298+03	1.990+00	3.703+00	4.302+10	1.994+10	5.470+05	2.163+05
66	2.376+10	3.042-01	2.373+11	1.314+03	1.994+00	3.713+00	4.371+10	2.024+10	5.491+05	2.180+05
67	2.412+10	3.034-01	2.400+11	1.331+03	1.997+00	3.723+00	4.439+10	2.054+10	5.511+05	2.196+05
68	2.448+10	3.027-01	2.426+11	1.347+03	2.001+00	3.733+00	4.507+10	2.085+10	5.532+05	2.213+05
69	2.484+10	3.019-01	2.453+11	1.364+03	2.005+00	3.743+00	4.575+10	2.115+10	5.552+05	2.229+05
70	2.520+10	3.012-01	2.480+11	1.380+03	2.008+00	3.753+00	4.644+10	2.145+10	5.572+05	2.245+05
71	2.556+10	3.005-01	2.506+11	1.397+03	2.012+00	3.763+00	4.712+10	2.175+10	5.591+05	2.261+05
72	2.592+10	2.998-01	2.533+11	1.414+03	2.015+00	3.772+00	4.781+10	2.206+10	5.611+05	2.277+05
73	2.628+10	2.990-01	2.559+11	1.431+03	2.019+00	3.782+00	4.849+10	2.236+10	5.631+05	2.293+05
74	2.664+10	2.984-01	2.585+11	1.447+03	2.022+00	3.792+00	4.918+10	2.266+10	5.650+05	2.308+05
75	2.700+10	2.977-01	2.612+11	1.464+03	2.026+00	3.801+00	4.987+10	2.296+10	5.669+05	2.324+05
76	2.736+10	2.970-01	2.639+11	1.481+03	2.029+00	3.811+00	5.056+10	2.327+10	5.688+05	2.339+05
77	2.772+10	2.963-01	2.664+11	1.498+03	2.032+00	3.820+00	5.124+10	2.357+10	5.707+05	2.355+05
78	2.808+10	2.957-01	2.690+11	1.515+03	2.036+00	3.829+00	5.193+10	2.387+10	5.726+05	2.370+05
79	2.844+10	2.950-01	2.716+11	1.532+03	2.039+00	3.838+00	5.262+10	2.417+10	5.745+05	2.385+05
80	2.880+10	2.944-01	2.742+11	1.549+03	2.042+00	3.848+00	5.331+10	2.447+10	5.763+05	2.400+05
81	2.916+10	2.937-01	2.768+11	1.566+03	2.045+00	3.857+00	5.401+10	2.478+10	5.781+05	2.415+05
82	2.952+10	2.931-01	2.794+11	1.583+03	2.049+00	3.866+00	5.470+10	2.508+10	5.600+05	2.430+05
83	2.988+10	2.925-01	2.820+11	1.600+03	2.052+00	3.875+00	5.539+10	2.533+10	5.818+05	2.445+05
84	3.024+10	2.919-01	2.845+11	1.617+03	2.055+00	3.884+00	5.608+10	2.563+10	5.836+05	2.459+05
85	3.060+10	2.912-01	2.871+11	1.635+03	2.058+00	3.893+00	5.678+10	2.598+10	5.854+05	2.474+05
86	3.096+10	2.906-01	2.897+11	1.652+03	2.061+00	3.901+00	5.747+10	2.628+10	5.872+05	2.488+05
87	3.132+10	2.901-01	2.922+11	1.669+03	2.064+00	3.910+00	5.817+10	2.658+10	5.889+05	2.503+05
88	3.168+10	2.895-01	2.948+11	1.686+03	2.067+00	3.919+00	5.886+10	2.688+10	5.907+05	2.517+05
89	3.204+10	2.889-01	2.973+11	1.704+03	2.070+00	3.928+00	5.956+10	2.718+10	5.924+05	2.532+05
90	3.240+10	2.883-01	2.998+11	1.721+03	2.073+00	3.936+00	6.026+10	2.748+10	5.942+05	2.546+05
91	3.276+10	2.877-01	3.024+11	1.739+03	2.076+00	3.945+00	6.096+10	2.778+10	5.959+05	2.560+05

TABLE B.3 (Continued)

25 PERCENT WATER (M_W = .25)

K	AIX	TVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	4.998-01	1.138+10	3.274+02	1.249+00	2.504+00	3.978+08	3.474+08	2.389+05	2.682+04
2	7.200+08	4.823-01	1.785+10	3.471+02	1.322+00	2.558+00	1.036+09	6.147+08	2.649+05	3.795+04
3	1.060+09	4.705-01	2.342+10	3.644+02	1.371+00	2.602+00	1.678+09	8.807+08	2.834+05	4.653+04
4	1.440+09	4.619-01	2.862+10	3.805+02	1.403+00	2.644+00	2.294+09	1.155+09	2.995+05	5.378+04
5	1.800+09	4.545-01	3.318+10	3.963+02	1.433+00	2.678+00	2.930+09	1.424+09	3.114+05	5.999+04
6	2.160+09	4.480-01	3.757+10	4.115+02	1.460+00	2.710+00	3.558+09	1.694+09	3.219+05	6.571+04
7	2.520+09	4.425-01	4.164+10	4.267+02	1.482+00	2.739+00	4.189+09	1.964+09	3.310+05	7.082+04
8	2.880+09	4.374-01	4.566+10	4.414+02	1.503+00	2.767+00	4.813+09	2.236+09	3.395+05	7.571+04
9	3.240+09	4.328-01	4.955+10	4.559+02	1.522+00	2.793+00	5.435+09	2.508+09	3.473+05	8.031+04
10	3.600+09	4.285-01	5.332+10	4.703+02	1.539+00	2.819+00	6.055+09	2.782+09	3.545+05	8.467+04
11	3.960+09	4.245-01	5.700+10	4.845+02	1.556+00	2.843+00	6.674+09	3.055+09	3.612+05	8.882+04
12	4.320+09	4.209-01	6.058+10	4.986+02	1.571+00	2.866+00	7.291+09	3.330+09	3.676+05	9.278+04
13	4.680+09	4.174-01	6.410+10	5.127+02	1.585+00	2.886+00	7.907+09	3.604+09	3.736+05	9.658+04
14	5.040+09	4.142-01	6.754+10	5.268+02	1.599+00	2.909+00	8.522+09	3.879+09	3.793+05	1.002+05
15	5.400+09	4.111-01	7.093+10	5.408+02	1.611+00	2.930+00	9.136+09	4.155+09	3.848+05	1.038+05
16	5.760+09	4.082-01	7.425+10	5.547+02	1.623+00	2.950+00	9.750+09	4.430+09	3.900+05	1.072+05
17	6.120+09	4.055-01	7.753+10	5.687+02	1.635+00	2.970+00	1.036+10	4.706+09	3.950+05	1.105+05
18	6.480+09	4.029-01	8.076+10	5.827+02	1.646+00	2.989+00	1.097+10	4.982+09	3.998+05	1.137+05
19	6.840+09	4.003-01	8.395+10	5.966+02	1.656+00	3.007+00	1.159+10	5.258+09	4.045+05	1.168+05
20	7.200+09	3.980-01	8.710+10	6.106+02	1.667+00	3.025+00	1.220+10	5.534+09	4.090+05	1.199+05
21	7.560+09	3.957-01	9.021+10	6.246+02	1.676+00	3.043+00	1.281+10	5.811+09	4.134+05	1.228+05
22	7.920+09	3.934-01	9.328+10	6.385+02	1.686+00	3.060+00	1.342+10	6.087+09	4.176+05	1.257+05
23	8.280+09	3.913-01	9.633+10	6.525+02	1.695+00	3.076+00	1.403+10	6.364+09	4.217+05	1.286+05
24	8.640+09	3.893-01	9.934+10	6.665+02	1.703+00	3.093+00	1.464+10	6.641+09	4.257+05	1.314+05
25	9.000+09	3.873-01	1.023+11	6.805+02	1.712+00	3.109+00	1.525+10	6.917+09	4.297+05	1.341+05
26	9.360+09	3.854-01	1.053+11	6.946+02	1.720+00	3.125+00	1.586+10	7.194+09	4.335+05	1.367+05
27	9.720+09	3.835-01	1.082+11	7.086+02	1.728+00	3.140+00	1.647+10	7.471+09	4.372+05	1.393+05
28	1.008+10	3.817-01	1.111+11	7.227+02	1.735+00	3.155+00	1.708+10	7.748+09	4.408+05	1.419+05
29	1.044+10	3.800-01	1.140+11	7.368+02	1.743+00	3.170+00	1.769+10	8.025+09	4.444+05	1.444+05
30	1.080+10	3.783-01	1.169+11	7.509+02	1.750+00	3.185+00	1.830+10	8.302+09	4.479+05	1.469+05
31	1.116+10	3.767-01	1.197+11	7.651+02	1.757+00	3.199+00	1.890+10	8.579+09	4.513+05	1.493+05
32	1.152+10	3.751-01	1.225+11	7.792+02	1.764+00	3.214+00	1.951+10	8.855+09	4.547+05	1.517+05
33	1.188+10	3.735-01	1.253+11	7.934+02	1.771+00	3.228+00	2.012+10	9.132+09	4.579+05	1.541+05
34	1.224+10	3.720-01	1.281+11	8.077+02	1.777+00	3.241+00	2.073+10	9.409+09	4.612+05	1.564+05
35	1.260+10	3.706-01	1.309+11	8.219+02	1.784+00	3.255+00	2.134+10	9.686+09	4.643+05	1.587+05
36	1.296+10	3.691-01	1.336+11	8.362+02	1.790+00	3.268+00	2.195+10	9.963+09	4.675+05	1.609+05
37	1.332+10	3.677-01	1.364+11	8.505+02	1.796+00	3.282+00	2.256+10	1.024+10	4.705+05	1.632+05
38	1.368+10	3.664-01	1.391+11	8.648+02	1.802+00	3.295+00	2.317+10	1.052+10	4.735+05	1.654+05
39	1.404+10	3.650-01	1.418+11	8.792+02	1.808+00	3.307+00	2.378+10	1.079+10	4.765+05	1.675+05
40	1.440+10	3.637-01	1.445+11	8.936+02	1.814+00	3.320+00	2.439+10	1.107+10	4.794+05	1.697+05
41	1.476+10	3.625-01	1.472+11	9.080+02	1.819+00	3.333+00	2.500+10	1.135+10	4.823+05	1.718+05
42	1.512+10	3.612-01	1.498+11	9.224+02	1.825+00	3.345+00	2.561+10	1.162+10	4.852+05	1.739+05
43	1.548+10	3.600-01	1.525+11	9.369+02	1.830+00	3.357+00	2.622+10	1.190+10	4.880+05	1.759+05
44	1.584+10	3.588-01	1.551+11	9.514+02	1.836+00	3.369+00	2.684+10	1.217+10	4.907+05	1.780+05
45	1.620+10	3.576-01	1.578+11	9.659+02	1.841+00	3.381+00	2.745+10	1.245+10	4.935+05	1.800+05
46	1.656+10	3.565-01	1.604+11	9.804+02	1.846+00	3.393+00	2.806+10	1.273+10	4.961+05	1.820+05
47	1.692+10	3.554-01	1.630+11	9.950+02	1.851+00	3.405+00	2.867+10	1.300+10	4.988+05	1.839+05
48	1.728+10	3.542-01	1.656+11	1.010+03	1.856+00	3.416+00	2.928+10	1.328+10	5.014+05	1.859+05
49	1.764+10	3.532-01	1.682+11	1.024+03	1.861+00	3.427+00	2.989+10	1.356+10	5.040+05	1.878+05

TABLE B.3 (Continued)

25 Percent Water (Continued)

50	1.800+10	3.351-01	1.812+11	1.050+03	1.894+00	3.486+00	3.170+10	1.457+10	5.098+05	1.897+05
51	1.836+10	3.341-01	1.839+11	1.065+03	1.699+00	3.497+00	3.234+10	1.486+10	5.122+05	1.916+05
52	1.872+10	3.331-01	1.866+11	1.080+03	1.904+00	3.509+00	3.298+10	1.515+10	5.147+05	1.935+05
53	1.908+10	3.321-01	1.893+11	1.095+03	1.908+00	3.520+00	3.363+10	1.544+10	5.171+05	1.953+05
54	1.944+10	3.311-01	1.919+11	1.111+03	1.913+00	3.531+00	3.427+10	1.573+10	5.195+05	1.972+05
55	1.980+10	3.302-01	1.946+11	1.126+03	1.917+00	3.542+00	3.491+10	1.602+10	5.218+05	1.990+05
56	2.016+10	3.293-01	1.972+11	1.142+03	1.922+00	3.553+00	3.555+10	1.631+10	5.242+05	2.008+05
57	2.052+10	3.283-01	1.998+11	1.157+03	1.926+00	3.564+00	3.620+10	1.660+10	5.265+05	2.026+05
58	2.088+10	3.274-01	2.025+11	1.173+03	1.930+00	3.574+00	3.684+10	1.689+10	5.288+05	2.044+05
59	2.124+10	3.266-01	2.051+11	1.188+03	1.934+00	3.585+00	3.749+10	1.718+10	5.310+05	2.061+05
60	2.160+10	3.257-01	2.077+11	1.204+03	1.938+00	3.595+00	3.813+10	1.747+10	5.333+05	2.079+05
61	2.196+10	3.248-01	2.103+11	1.219+03	1.943+00	3.606+00	3.878+10	1.776+10	5.355+05	2.096+05
62	2.232+10	3.240-01	2.129+11	1.235+03	1.947+00	3.616+00	3.942+10	1.804+10	5.377+05	2.113+05
63	2.268+10	3.232-01	2.155+11	1.250+03	1.950+00	3.626+00	4.007+10	1.833+10	5.399+05	2.130+05
64	2.304+10	3.223-01	2.180+11	1.266+03	1.954+00	3.636+00	4.072+10	1.862+10	5.421+05	2.147+05
65	2.340+10	3.215-01	2.206+11	1.282+03	1.958+00	3.646+00	4.136+10	1.891+10	5.442+05	2.163+05
66	2.376+10	3.207-01	2.232+11	1.298+03	1.962+00	3.656+00	4.201+10	1.920+10	5.463+05	2.180+05
67	2.412+10	3.199-01	2.257+11	1.313+03	1.966+00	3.666+00	4.266+10	1.949+10	5.484+05	2.197+05
68	2.448+10	3.192-01	2.283+11	1.329+03	1.970+00	3.676+00	4.331+10	1.977+10	5.505+05	2.213+05
69	2.484+10	3.184-01	2.308+11	1.345+03	1.973+00	3.686+00	4.396+10	2.006+10	5.526+05	2.229+05
70	2.520+10	3.177-01	2.333+11	1.361+03	1.977+00	3.695+00	4.461+10	2.035+10	5.546+05	2.245+05
71	2.556+10	3.169-01	2.359+11	1.377+03	1.980+00	3.705+00	4.526+10	2.064+10	5.567+05	2.261+05
72	2.592+10	3.162-01	2.384+11	1.393+03	1.984+00	3.715+00	4.591+10	2.092+10	5.587+05	2.277+05
73	2.628+10	3.155-01	2.409+11	1.408+03	1.987+00	3.724+00	4.656+10	2.121+10	5.607+05	2.293+05
74	2.664+10	3.147-01	2.434+11	1.424+03	1.991+00	3.733+00	4.721+10	2.150+10	5.627+05	2.308+05
75	2.700+10	3.140-01	2.459+11	1.440+03	1.994+00	3.743+00	4.786+10	2.178+10	5.647+05	2.324+05
76	2.736+10	3.133-01	2.484+11	1.456+03	1.998+00	3.752+00	4.851+10	2.207+10	5.666+05	2.339+05
77	2.772+10	3.126-01	2.509+11	1.472+03	2.001+00	3.761+00	4.917+10	2.236+10	5.686+05	2.355+05
78	2.808+10	3.120-01	2.533+11	1.489+03	2.004+00	3.770+00	4.982+10	2.265+10	5.705+05	2.370+05
79	2.844+10	3.113-01	2.558+11	1.505+03	2.008+00	3.779+00	5.047+10	2.293+10	5.724+05	2.385+05
80	2.880+10	3.106-01	2.583+11	1.521+03	2.011+00	3.788+00	5.113+10	2.322+10	5.743+05	2.400+05
81	2.916+10	3.100-01	2.608+11	1.537+03	2.014+00	3.797+00	5.178+10	2.350+10	5.762+05	2.415+05
82	2.952+10	3.093-01	2.632+11	1.553+03	2.017+00	3.806+00	5.244+10	2.379+10	5.781+05	2.430+05
83	2.988+10	3.087-01	2.657+11	1.569+03	2.021+00	3.815+00	5.309+10	2.408+10	5.799+05	2.445+05
84	3.024+10	3.081-01	2.681+11	1.586+03	2.024+00	3.823+00	5.375+10	2.436+10	5.618+05	2.460+05
85	3.060+10	3.074-01	2.706+11	1.602+03	2.027+00	3.832+00	5.441+10	2.465+10	5.836+05	2.474+05
86	3.096+10	3.068-01	2.730+11	1.618+03	2.030+00	3.841+00	5.506+10	2.493+10	5.854+05	2.489+05
87	3.132+10	3.062-01	2.754+11	1.634+03	2.033+00	3.849+00	5.572+10	2.522+10	5.872+05	2.503+05
88	3.168+10	3.056-01	2.779+11	1.651+03	2.036+00	3.858+00	5.638+10	2.551+10	5.890+05	2.517+05
89	3.204+10	3.050-01	2.803+11	1.667+03	2.039+00	3.866+00	5.704+10	2.579+10	5.908+05	2.532+05
90	3.240+10	3.044-01	2.827+11	1.684+03	2.042+00	3.875+00	5.770+10	2.608+10	5.926+05	2.546+05
91	3.276+10	3.038-01	2.851+11	1.700+03	2.045+00	3.883+00	5.836+10	2.636+10	5.944+05	2.560+05
92	3.312+10	3.032-01	2.875+11	1.717+03	2.048+00	3.891+00	5.902+10	2.665+10	5.961+05	2.574+05
93	3.348+10	3.027-01	2.899+11	1.733+03	2.051+00	3.900+00	5.968+10	2.693+10	5.979+05	2.588+05
94	3.384+10	3.021-01	2.923+11	1.750+03	2.054+00	3.908+00	6.034+10	2.722+10	5.996+05	2.602+05
95	3.420+10	3.015-01	2.947+11	1.766+03	2.056+00	3.916+00	6.100+10	2.750+10	6.013+05	2.616+05
96	3.456+10	3.010-01	2.971+11	1.783+03	2.059+00	3.924+00	6.166+10	2.778+10	6.030+05	2.629+05
97	3.492+10	3.004-01	2.995+11	1.799+03	2.062+00	3.932+00	6.232+10	2.807+10	6.047+05	2.643+05
98	3.528+10	2.999-01	3.019+11	1.816+03	2.065+00	3.940+00	6.299+10	2.835+10	6.064+05	2.657+05

TABLE B.3 (Continued)

30 PERCENT WATER (M_W = .30)

K	AIX	TVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	5.234-01	1.043+10	3.275+02	1.235+00	2.495+00	4.148+08	3.365+08	2.306+05	2.679+04
2	7.200+08	5.046-01	1.644+10	3.472+02	1.306+00	2.545+00	1.028+09	5.881+08	2.566+05	3.794+04
3	1.080+09	4.924-01	2.163+10	3.645+02	1.352+00	2.588+00	1.643+09	8.389+08	2.757+05	4.647+04
4	1.440+09	4.834-01	2.640+10	3.808+02	1.389+00	2.626+00	2.244+09	1.096+09	2.917+05	5.360+04
5	1.800+09	4.753-01	3.080+10	3.964+02	1.414+00	2.660+00	2.851+09	1.349+09	3.040+05	5.999+04
6	2.160+09	4.688-01	3.484+10	4.118+02	1.439+00	2.690+00	3.459+09	1.603+09	3.146+05	6.558+04
7	2.520+09	4.628-01	3.877+10	4.267+02	1.461+00	2.718+00	4.062+09	1.859+09	3.242+05	7.083+04
8	2.880+09	4.575-01	4.257+10	4.413+02	1.482+00	2.745+00	4.663+09	2.116+09	3.329+05	7.573+04
9	3.240+09	4.526-01	4.624+10	4.557+02	1.500+00	2.770+00	5.261+09	2.374+09	3.408+05	8.033+04
10	3.600+09	4.482-01	4.980+10	4.700+02	1.518+00	2.794+00	5.858+09	2.632+09	3.482+05	8.469+04
11	3.960+09	4.441-01	5.328+10	4.841+02	1.534+00	2.818+00	6.454+09	2.891+09	3.552+05	8.884+04
12	4.320+09	4.403-01	5.667+10	4.981+02	1.548+00	2.840+00	7.048+09	3.151+09	3.617+05	9.280+04
13	4.680+09	4.367-01	6.000+10	5.121+02	1.562+00	2.861+00	7.641+09	3.411+09	3.678+05	9.660+04
14	5.040+09	4.333-01	6.326+10	5.260+[illegible]	1.575+00	2.882+00	8.232+09	3.672+09	3.737+05	1.003+05
15	5.400+09	4.302-01	6.647+10	5.398+02	1.588+00	2.902+00	8.823+09	3.933+09	3.793+05	1.038+05
16	5.760+09	4.272-01	6.962+10	5.536+02	1.600+00	2.921+00	9.413+09	4.194+09	3.846+05	1.072+05
17	6.120+09	4.243-01	7.273+10	5.674+02	1.611+00	2.940+00	1.000+10	4.456+09	3.898+05	1.105+05
18	6.480+09	4.216-01	7.579+10	5.812+02	1.622+00	2.958+00	1.059+10	4.718+09	3.947+05	1.137+05
19	6.840+09	4.190-01	7.882+10	5.949+02	1.632+00	2.976+00	1.118+10	4.980+09	3.995+05	1.168+05
20	7.200+09	4.165-01	8.18[illegible]+10	6.086+02	1.642+00	2.994+00	1.177+10	5.243+09	4.041+05	1.199+05
21	7.560+09	4.141-01	8.476+10	6.223+02	1.652+00	3.011+00	1.235+10	5.505+09	4.086+05	1.229+05
22	7.920+09	4.119-01	8.768+10	6.360+02	1.661+00	3.027+00	1.294+10	5.768+09	4.129+05	1.258+05
23	8.280+09	4.097-01	9.057+10	6.498+02	1.670+00	3.044+00	1.353+10	6.031+09	4.171+05	1.286+05
24	8.640+09	4.075-01	9.344+10	6.635+02	1.676+00	3.059+00	1.411+10	6.294+09	4.213+05	1.314+05
25	9.000+09	4.055-01	9.627+10	6.772+02	1.687+00	3.075+00	1.470+10	6.557+09	4.253+05	1.341+05
26	9.360+09	4.035-01	9.909+10	6.909+02	1.695+00	3.090+00	1.529+10	6.821+09	4.292+05	1.367+05
27	9.720+09	4.016-01	1.019+11	7.046+02	1.703+00	3.105+00	1.587+10	7.084+09	4.330+05	1.393+05
28	1.008+10	3.998-01	1.046+11	7.184+02	1.710+00	3.120+00	1.646+10	7.347+09	4.367+05	1.419+05
29	1.044+10	3.980-01	1.074+11	7.321+02	1.718+00	3.135+00	1.704+10	7.611+09	4.403+05	1.444+05
30	1.080+10	3.962-01	1.101+11	7.459+02	1.725+00	3.149+00	1.763+10	7.874+09	4.439+05	1.469+05
31	1.116+10	3.945-01	1.128+11	7.597+02	1.732+00	3.163+00	1.821+10	8.138+09	4.474+05	1.493+05
32	1.152+10	3.929-01	1.155+11	7.735+02	1.739+00	3.177+00	1.880+10	8.402+09	4.508+05	1.517+05
33	1.188+10	3.913-01	1.182+11	7.873+02	1.745+00	3.190+00	1.938+10	8.665+09	4.542+05	1.541+05
34	1.224+10	3.897-01	1.208+11	8.011+02	1.752+00	3.204+00	1.997+10	8.929+09	4.575+05	1.564+05
35	1.260+10	3.882-01	1.235+11	8.150+02	1.758+00	3.217+00	2.055+10	9.192+09	4.607+05	1.587+05
36	1.296+10	3.868-01	1.261+11	8.289+02	1.764+00	3.230+00	2.114+10	9.456+09	4.639+05	1.609+05
37	1.332+10	3.853-01	1.287+11	8.427+02	1.770+00	3.243+00	2.172+10	9.720+09	4.670+05	1.632+05
38	1.368+10	3.839-01	1.313+11	8.566+02	1.776+00	3.256+00	2.231+10	9.983+09	4.701+05	1.654+05
39	1.404+10	3.825-01	1.339+11	8.706+02	1.782+00	3.268+00	2.289+10	1.025+10	4.732+05	1.675+05
40	1.440+10	3.812-01	1.364+11	8.845+02	1.788+00	3.280+00	2.348+10	1.051+10	4.762+05	1.697+05
41	1.476+10	3.799-01	1.390+11	8.984+02	1.793+00	3.293+00	2.406+10	1.077+10	4.791+05	1.718+05
42	1.512+10	3.786-01	1.415+11	9.124+02	1.799+00	3.305+00	2.465+10	1.104+10	4.820+05	1.739+05
43	1.548+10	3.773-01	1.440+11	9.264+02	1.804+00	3.317+00	2.523+10	1.130+10	4.849+05	1.759+05
44	1.584+10	3.761-01	1.466+11	9.404+02	1.810+00	3.328+00	2.582+10	1.156+10	4.877+05	1.780+05
45	1.620+10	3.749-01	1.491+11	9.545+02	1.815+00	3.340+00	2.640+10	1.183+10	4.905+05	1.800+05
46	1.656+10	3.737-01	1.515+11	9.685+02	1.820+00	3.351+00	2.699+10	1.209+10	4.932+05	1.820+05
47	1.692+10	3.726-01	1.540+11	9.826+02	1.825+00	3.363+00	2.758+10	1.235+10	4.959+05	1.839+05
48	1.728+10	3.714-01	1.565+11	9.967+02	1.830+00	3.374+00	2.616+10	1.262+10	4.986+05	1.859+05
49	1.764+10	3.703-01	1.590+11	1.011+03	1.835+00	3.385+00	2.875+10	1.288+10	5.012+05	1.878+05
50	1.800+10	3.521-01	1.707+11	1.039+03	1.866+00	3.439+00	3.051+10	1.383+10	5.066+05	1.897+05
51	1.836+10	3.511-01	1.733+11	1.054+03	1.870+00	3.450+00	3.112+10	1.411+10	5.091+05	1.916+05

TABLE B.3 (Continued)

30 Percent Water (Continued)

52	1.872+10	3.500-01	1.758+11	1.068+03	1.875+00	3.461+00	3.173+10	1.438+10	5.116+05	1.935+05
53	1.908+10	3.490-01	1.784+11	1.083+03	1.880+00	3.472+00	3.235+10	1.466+10	5.141+05	1.953+05
54	1.944+10	3.480-01	1.809+11	1.098+03	1.884+00	3.483+00	3.296+10	1.493+10	5.165+05	1.972+05
55	1.980+10	3.471-01	1.834+11	1.113+03	1.888+00	3.493+00	3.357+10	1.521+10	5.189+05	1.990+05
56	2.016+10	3.461-01	1.860+11	1.127+03	1.893+00	3.504+00	3.419+10	1.548+10	5.213+05	2.008+05
57	2.052+10	3.452-01	1.885+11	1.142+03	1.897+00	3.515+00	3.480+10	1.576+10	5.237+05	2.026+05
58	2.088+10	3.443-01	1.910+11	1.157+03	1.901+00	3.525+00	3.542+10	1.603+10	5.260+05	2.044+05
59	2.124+10	3.433-01	1.935+11	1.172+03	1.905+00	3.535+00	3.603+10	1.631+10	5.284+05	2.061+05
60	2.160+10	3.424-01	1.959+11	1.187+03	1.910+00	3.546+00	3.665+10	1.658+10	5.307+05	2.079+05
61	2.196+10	3.416-01	1.984+11	1.202+03	1.91[illegible]+00	3.556+00	3.726+10	1.686+10	5.329+05	2.096+05
62	2.232+10	3.407-01	2.009+11	1.217+03	1.91[illegible]+00	3.566+00	3.788+10	1.713+10	5.352+05	2.113+05
63	2.268+10	3.398-01	2.033+11	1.232+03	1.922+00	3.576+00	3.850+10	1.741+10	5.374+05	2.130+05
64	2.304+10	3.390-01	2.058+11	1.247+03	1.926+00	3.586+00	3.911+10	1.768+10	5.396+05	2.147+05
65	2.340+10	3.382-01	2.082+11	1.262+03	1.929+00	3.596+00	3.973+10	1.796+10	5.418+05	2.164+05
66	2.376+10	3.373-01	2.107+11	1.277+03	1.933+00	3.605+00	4.035+10	1.823+10	5.440+05	2.180+05
67	2.412+10	3.365-01	2.131+11	1.292+03	1.937+00	3.615+00	4.096+10	1.851+10	5.461+05	2.197+05
68	2.448+10	3.357-01	2.155+11	1.307+03	1.941+00	3.625+00	4.158+10	1.878+10	5.483+05	2.213+05
69	2.484+10	3.350-01	2.179+11	1.322+03	1.944+00	3.634+00	4.220+10	1.905+10	5.504+05	2.229+05
70	2.520+10	3.342-01	2.204+11	1.337+03	1.948+00	3.644+00	4.282+10	1.933+10	5.525+05	2.245+05
71	2.556+10	3.334-01	2.228+11	1.352+03	1.952+00	3.653+00	4.344+10	1.960+10	5.546+05	2.261+05
72	2.592+10	3.327-01	2.252+11	1.367+03	1.955+00	3.662+00	4.406+10	1.987+10	5.566+05	2.277+05
73	2.628+10	3.319-01	2.276+11	1.383+03	1.959+00	3.671+00	4.468+10	2.015+10	5.587+05	2.293+05
74	2.664+10	3.312-01	2.299+11	1.398+03	1.962+00	3.681+00	4.530+10	2.042+10	5.607+05	2.309+05
75	2.700+10	3.305-01	2.323+11	1.413+03	1.966+00	3.690+00	4.592+10	2.069+10	5.627+05	2.324+05
76	2.736+10	3.297-01	2.347+11	1.428+03	1.969+00	3.699+00	4.654+10	2.097+10	5.647+05	2.340+05
77	2.772+10	3.290-01	2.371+11	1.444+03	1.972+00	3.708+00	4.716+10	2.124+10	5.667+05	2.355+05
78	2.808+10	3.283-01	2.394+11	1.459+03	1.976+00	3.717+00	4.778+10	2.151+10	5.687+05	2.370+05
79	2.844+10	3.276-01	2.418+11	1.474+03	1.979+00	3.725+00	4.840+10	2.179+10	5.707+05	2.385+05
80	2.880+10	3.270-01	2.442+11	1.490+03	1.982+00	3.734+00	4.902+10	2.206+10	5.726+05	2.400+05
81	2.916+10	3.263-01	2.465+11	1.505+03	1.986+00	3.743+00	4.964+10	2.233+10	5.745+05	2.415+05
82	2.952+10	3.256-01	2.488+11	1.521+03	1.989+00	3.752+00	5.027+10	2.260+10	5.764+05	2.430+05
83	2.988+10	3.250-01	2.512+11	1.536+03	1.992+00	3.760+00	5.089+10	2.288+10	5.784+05	2.445+05
84	3.024+10	3.243-01	2.535+11	1.551+03	1.995+00	3.769+00	5.151+10	2.315+10	5.802+05	2.460+05
85	3.060+10	3.237-01	2.559+11	1.567+03	1.998+00	3.777+00	5.214+10	2.342+10	5.821+05	2.474+05
86	3.096+10	3.230-01	2.582+11	1.582+03	2.001+00	3.786+00	5.276+10	2.369+10	5.840+05	2.489+05
87	3.132+10	3.224-01	2.605+11	1.598+03	2.004+00	3.794+00	5.338+10	2.397+10	5.858+05	2.503+05
88	3.168+10	3.218-01	2.628+11	1.613+03	2.007+00	3.802+00	5.401+10	2.424+10	5.877+05	2.518+05
89	3.204+10	3.212-01	2.651+11	1.629+03	2.010+00	3.811+00	5.463+10	2.451+10	5.895+05	2.532+05
90	3.240+10	3.206-01	2.674+11	1.645+03	2.013+00	3.819+00	5.526+10	2.478+10	5.913+05	2.546+05
91	3.276+10	3.200-01	2.697+11	1.660+03	2.016+00	3.827+00	5.589+10	2.505+10	5.931+05	2.560+05
92	3.312+10	3.194-01	2.720+11	1.676+03	2.019+00	3.835+00	5.651+10	2.532+10	5.949+05	2.574+05
93	3.348+10	3.188-01	2.743+11	1.691+03	2.022+00	3.843+00	5.714+10	2.559+10	5.967+05	2.588+05
94	3.384+10	3.182-01	2.766+11	1.707+03	2.025+00	3.852+00	5.776+10	2.587+10	5.985+05	2.602+05
95	3.420+10	3.176-01	2.789+11	1.723+03	2.028+00	3.860+00	5.839+10	2.614+10	6.002+05	2.616+05
96	3.456+10	3.170-01	2.812+11	1.738+03	2.031+00	3.868+00	5.902+10	2.641+10	6.020+05	2.630+05
97	3.492+10	3.165-01	2.835+11	1.754+03	2.033+00	3.875+00	5.965+10	2.668+10	6.037+05	2.643+05
98	3.528+10	3.159-01	2.857+11	1.770+03	2.036+00	3.883+00	6.028+10	2.695+10	6.054+05	2.657+05
99	3.564+10	3.154-01	2.880+11	1.786+03	2.039+00	3.891+00	6.090+10	2.722+10	6.071+05	2.670+05
100	3.600+10	3.148-01	2.903+11	1.801+03	2.042+00	3.899+00	6.153+10	2.749+10	6.089+05	2.684+05
101	3.636+10	3.143-01	2.925+11	1.817+03	2.044+00	3.907+00	6.216+10	2.776+10	6.106+05	2.697+05
102	3.672+10	3.137-01	2.948+11	1.833+03	2.047+00	3.914+00	6.279+10	2.803+10	6.122+05	2.711+05
103	3.708+10	3.132-01	2.970+11	1.849+03	2.050+00	3.922+00	6.342+10	2.830+10	6.139+05	2.724+05
104	3.744+10	3.127-01	2.993+11	1.865+03	2.052+00	3.930+00	6.405+10	2.857+10	6.156+05	2.737+05
105	3.780+10	3.121-01	3.015+11	1.881+03	2.055+00	3.937+00	6.468+10	2.884+10	6.173+05	2.750+05

TABLE B.3 (Continued)

100 PERCENT WATER (M_W = 1.0)

K	AIX	TVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	8.689-01	5.407+09	3.211+02	1.151+00	2.400+00	3.600+08	3.600+08	2.021+05	2.681+04
2	7.200+08	8.330-01	8.522+09	3.353+02	1.201+00	2.400+00	7.200+08	7.200+08	2.251+05	3.793+04
3	1.080+09	8.098-01	1.123+10	3.479+02	1.235+00	2.400+00	1.080+09	1.080+09	2.423+05	4.643+04
4	1.440+09	7.923-01	1.374+10	3.597+02	1.262+00	2.400+00	1.440+09	1.440+09	2.565+05	5.366+04
5	1.800+09	7.780-01	1.614+10	3.709+02	1.285+00	2.400+00	1.800+09	1.800+09	2.690+05	6.011+04
6	2.160+09	7.664-01	1.837+10	3.819+02	1.305+00	2.400+00	2.160+09	2.160+09	2.799+05	6.576+04
7	2.520+09	7.565-01	2.051+10	3.926+02	1.322+00	2.400+00	2.520+09	2.520+09	2.897+05	7.092+04
8	2.880+09	7.475-01	2.264+10	4.031+02	1.338+00	2.400+00	2.880+09	2.880+09	2.989+05	7.588+04
9	3.240+09	7.395-01	2.469+10	4.134+02	1.352+00	2.400+00	3.240+09	3.240+09	3.074+05	8.047+04
10	3.600+09	7.323-01	2.670+10	4.237+02	1.366+00	2.400+00	3.600+09	3.600+09	3.153+05	8.482+04
11	3.960+09	7.257-01	2.866+10	4.338+02	1.378+00	2.400+00	3.960+09	3.960+09	3.228+05	8.896+04
12	4.320+09	7.197-01	3.060+10	4.439+02	1.390+00	2.400+00	4.320+09	4.320+09	3.299+05	9.291+04
13	4.680+09	7.140-01	3.250+10	4.539+02	1.400+00	2.400+00	4.680+09	4.680+09	3.367+05	9.670+04
14	5.040+09	7.088-01	3.437+10	4.638+02	1.411+00	2.400+00	5.040+09	5.040+09	3.431+05	1.004+05
15	5.400+09	7.039-01	3.622+10	4.736+02	1.421+00	2.400+00	5.400+09	5.400+09	3.493+05	1.039+05
16	5.760+09	6.993-01	3.805+10	4.835+02	1.430+00	2.400+00	5.760+09	5.760+09	3.553+05	1.073+05
17	6.120+09	6.949-01	3.985+10	4.932+02	1.439+00	2.400+00	6.120+09	6.120+09	3.610+05	1.106+05
18	6.480+09	6.908-01	4.164+10	5.030+02	1.448+00	2.400+00	6.480+09	6.480+09	3.665+05	1.138+05
19	6.840+09	6.868-01	4.340+10	5.127+02	1.456+00	2.400+00	6.840+09	6.840+09	3.719+05	1.169+05
20	7.200+09	6.831-01	4.515+10	5.223+02	1.464+00	2.400+00	7.200+09	7.200+09	3.771+05	1.200+05
21	7.560+09	6.795-01	4.689+10	5.320+02	1.472+00	2.400+00	7.560+09	7.560+09	3.821+05	1.229+05
22	7.920+09	6.761-01	4.860+10	5.416+02	1.479+00	2.400+00	7.920+09	7.920+09	3.870+05	1.258+05
23	8.280+09	6.728-01	5.031+10	5.512+02	1.486+00	2.400+00	8.280+09	8.280+09	3.918+05	1.286+05
24	8.640+09	6.697-01	5.200+10	5.607+02	1.493+00	2.400+00	8.640+09	8.640+09	3.964+05	1.314+05
25	9.000+09	6.667-01	5.368+10	5.703+02	1.500+00	2.400+00	9.000+09	9.000+09	4.009+05	1.341+05
26	9.360+09	6.637-01	5.535+10	5.798+02	1.507+00	2.400+00	9.360+09	9.360+09	4.054+05	1.368+05
27	9.720+09	6.609-01	5.700+10	5.893+02	1.513+00	2.400+00	9.720+09	9.720+09	4.097+05	1.394+05
28	1.008+10	6.582-01	5.865+10	5.988+02	1.519+00	2.400+00	1.008+10	1.008+10	4.139+05	1.420+05
29	1.044+10	6.556-01	6.028+10	6.083+02	1.525+00	2.400+00	1.044+10	1.044+10	4.180+05	1.445+05
30	1.080+10	6.531-01	6.191+10	6.178+02	1.531+00	2.400+00	1.080+10	1.080+10	4.221+05	1.469+05
31	1.116+10	6.506-01	6.353+10	6.273+02	1.537+00	2.400+00	1.116+10	1.116+10	4.261+05	1.494+05
32	1.152+10	6.482-01	6.513+10	6.367+02	1.543+00	2.400+00	1.152+10	1.152+10	4.300+05	1.518+05
33	1.188+10	6.459-01	6.673+10	6.462+02	1.548+00	2.400+00	1.188+10	1.188+10	4.338+05	1.541+05
34	1.224+10	6.436-01	6.832+10	6.556+02	1.554+00	2.400+00	1.224+10	1.224+10	4.375+05	1.564+05
35	1.260+10	6.414-01	6.991+10	6.650+02	1.559+00	2.400+00	1.260+10	1.260+10	4.412+05	1.587+05
36	1.296+10	6.393-01	7.148+10	6.744+02	1.564+00	2.400+00	1.296+10	1.296+10	4.449+05	1.610+05
37	1.332+10	6.372-01	7.305+10	6.838+02	1.569+00	2.400+00	1.332+10	1.332+10	4.484+05	1.632+05
38	1.368+10	6.352-01	7.461+10	6.932+02	1.574+00	2.400+00	1.368+10	1.368+10	4.519+05	1.654+05
39	1.404+10	6.332-01	7.616+10	7.026+02	1.579+00	2.400+00	1.404+10	1.404+10	4.554+05	1.675+05
40	1.440+10	6.313-01	7.771+10	7.120+02	1.584+00	2.400+00	1.440+10	1.440+10	4.588+05	1.697+05
41	1.476+10	6.294-01	7.925+10	7.214+02	1.589+00	2.400+00	1.476+10	1.476+10	4.622+05	1.718+05
42	1.512+10	6.276-01	8.079+10	7.307+02	1.593+00	2.400+00	1.512+10	1.512+10	4.655+05	1.739+05
43	1.548+10	6.258-01	8.231+10	7.401+02	1.598+00	2.400+00	1.548+10	1.548+10	4.687+05	1.759+05
44	1.584+10	6.240-01	8.384+10	7.495+02	1.602+00	2.400+00	1.584+10	1.584+10	4.719+05	1.780+05
45	1.620+10	6.223-01	8.535+10	7.588+02	1.607+00	2.400+00	1.620+10	1.620+10	4.751+05	1.800+05
46	1.656+10	6.206-01	8.687+10	7.682+02	1.611+00	2.400+00	1.656+10	1.656+10	4.782+05	1.820+05
47	1.692+10	6.190-01	8.837+10	7.775+02	1.616+00	2.400+00	1.692+10	1.692+10	4.813+05	1.839+05
48	1.728+10	6.174-01	8.987+10	7.868+02	1.620+00	2.400+00	1.728+10	1.728+10	4.844+05	1.859+05
49	1.764+10	6.158-01	9.137+10	7.962+02	1.624+00	2.400+00	1.764+10	1.764+10	4.874+05	1.878+05

TABLE B.3 (Continued)

100 Percent Water (Continued)

NOT REPRODUCIBLE

50	1.800+10	3.692-01	1.614+11	1.025+03	1.839+00	3.396+00	2.933+10	1.314+10	5.039+05	1.897+05
51	1.836+10	3.681-01	1.639+11	1.039+03	1.844+00	3.407+00	2.992+10	1.341+10	5.064+05	1.916+05
52	1.872+10	3.671-01	1.663+11	1.053+03	1.849+00	3.418+00	3.051+10	1.367+10	5.090+05	1.935+05
53	1.908+10	3.660-01	1.687+11	1.067+03	1.853+00	3.429+00	3.109+10	1.393+10	5.115+05	1.953+05
54	1.944+10	3.650-01	1.711+11	1.082+03	1.858+00	3.439+00	3.168+10	1.419+10	5.140+05	1.972+05
55	1.980+10	3.640-01	1.735+11	1.096+03	1.862+00	3.450+00	3.227+10	1.446+10	5.165+05	1.990+05
56	2.016+10	3.630-01	1.759+11	1.110+03	1.866+00	3.460+00	3.286+10	1.472+10	5.189+05	2.008+05
57	2.052+10	3.621-01	1.783+11	1.124+03	1.871+00	3.470+00	3.344+10	1.498+10	5.213+05	2.026+05
58	2.088+10	3.611-01	1.807+11	1.139+03	1.875+00	3.480+00	3.403+10	1.524+10	5.237+05	2.044+05
59	2.124+10	3.602-01	1.831+11	1.153+03	1.879+00	3.491+00	3.462+10	1.551+10	5.261+05	2.061+05
60	2.160+10	3.593-01	1.855+11	1.167+03	1.883+00	3.501+00	3.521+10	1.577+10	5.284+05	2.079+05
61	2.196+10	3.584-01	1.878+11	1.182+03	1.887+00	3.511+00	3.580+10	1.603+10	5.308+05	2.096+05
62	2.232+10	3.575-01	1.902+11	1.196+03	1.891+00	3.520+00	3.638+10	1.629+10	5.331+05	2.113+05
63	2.268+10	3.566-01	1.925+11	1.210+03	1.895+00	3.530+00	3.697+10	1.655+10	5.353+05	2.130+05
64	2.304+10	3.557-01	1.949+11	1.225+03	1.899+00	3.540+00	3.756+10	1.682+10	5.376+05	2.147+05
65	2.340+10	3.549-01	1.972+11	1.239+03	1.903+00	3.549+00	3.815+10	1.708+10	5.398+05	2.164+05
66	2.376+10	3.540-01	1.995+11	1.254+03	1.907+00	3.559+00	3.874+10	1.734+10	5.420+05	2.180+05
67	2.412+10	3.532-01	2.019+11	1.268+03	1.911+00	3.568+00	3.933+10	1.760+10	5.442+05	2.197+05
68	2.448+10	3.524-01	2.042+11	1.283+03	1.914+00	3.578+00	3.992+10	1.786+10	5.464+05	2.213+05
69	2.484+10	3.516-01	2.065+11	1.297+03	1.918+00	3.587+00	4.051+10	1.812+10	5.486+05	2.229+05
70	2.520+10	3.508-01	2.088+11	1.312+03	1.922+00	3.596+00	4.110+10	1.839+10	5.507+05	2.245+05
71	2.556+10	3.500-01	2.111+11	1.326+03	1.925+00	3.605+00	4.169+10	1.865+10	5.528+05	2.261+05
72	2.592+10	3.492-01	2.134+11	1.341+03	1.929+00	3.615+00	4.228+10	1.891+10	5.549+05	2.277+05
73	2.628+10	3.484-01	2.157+11	1.355+03	1.932+00	3.624+00	4.287+10	1.917+10	5.570+05	2.293+05
74	2.664+10	3.477-01	2.179+11	1.370+03	1.936+00	3.633+00	4.347+10	1.943+10	5.591+05	2.309+05
75	2.700+10	3.469-01	2.202+11	1.384+03	1.939+00	3.641+00	4.406+10	1.969+10	5.612+05	2.324+05
76	2.736+10	3.462-01	2.225+11	1.399+03	1.943+00	3.650+00	4.465+10	1.995+10	5.632+05	2.340+05
77	2.772+10	3.455-01	2.248+11	1.414+03	1.946+00	3.659+00	4.524+10	2.021+10	5.652+05	2.355+05
78	2.808+10	3.448-01	2.270+11	1.428+03	1.949+00	3.668+00	4.583+10	2.047+10	5.672+05	2.370+05
79	2.844+10	3.440-01	2.293+11	1.443+03	1.953+00	3.676+00	4.643+10	2.073+10	5.692+05	2.385+05
80	2.880+10	3.433-01	2.315+11	1.458+03	1.956+00	3.685+00	4.702+10	2.099+10	5.712+05	2.400+05
81	2.916+10	3.427-01	2.338+11	1.472+03	1.959+00	3.694+00	4.761+10	2.125+10	5.732+05	2.415+05
82	2.952+10	3.420-01	2.360+11	1.487+03	1.962+00	3.702+00	4.821+10	2.151+10	5.751+05	2.430+05
83	2.988+10	3.413-01	2.382+11	1.502+03	1.965+00	3.711+00	4.880+10	2.177+10	5.771+05	2.445+05
84	3.024+10	3.406-01	2.405+11	1.516+03	1.969+00	3.719+00	4.939+10	2.203+10	5.790+05	2.460+05
85	3.060+10	3.400-01	2.427+11	1.531+03	1.972+00	3.727+00	4.999+10	2.229+10	5.809+05	2.474+05
86	3.096+10	3.393-01	2.449+11	1.546+03	1.975+00	3.735+00	5.058+10	2.255+10	5.828+05	2.489+05
87	3.132+10	3.387-01	2.471+11	1.561+03	1.978+00	3.744+00	5.118+10	2.281+10	5.847+05	2.503+05
88	3.168+10	3.380-01	2.494+11	1.576+03	1.981+00	3.752+00	5.177+10	2.307+10	5.865+05	2.518+05
89	3.204+10	3.374-01	2.516+11	1.590+03	1.984+00	3.760+00	5.237+10	2.333+10	5.884+05	2.532+05
90	3.240+10	3.368-01	2.538+11	1.605+03	1.987+00	3.768+00	5.296+10	2.359+10	5.903+05	2.546+05
91	3.276+10	3.361-01	2.560+11	1.620+03	1.990+00	3.776+00	5.356+10	2.385+10	5.921+05	2.560+05
92	3.312+10	3.355-01	2.582+11	1.635+03	1.993+00	3.784+00	5.415+10	2.411+10	5.939+05	2.574+05
93	3.348+10	3.349-01	2.604+11	1.650+03	1.996+00	3.792+00	5.475+10	2.436+10	5.957+05	2.588+05
94	3.384+10	3.343-01	2.625+11	1.665+03	1.999+00	3.800+00	5.535+10	2.462+10	5.975+05	2.602+05
95	3.420+10	3.337-01	2.647+11	1.680+03	2.001+00	3.808+00	5.594+10	2.488+10	5.993+05	2.616+05
96	3.456+10	3.331-01	2.669+11	1.695+03	2.004+00	3.816+00	5.654+10	2.514+10	6.011+05	2.630+05
97	3.492+10	3.326-01	2.691+11	1.710+03	2.007+00	3.823+00	5.714+10	2.540+10	6.029+05	2.643+05
98	3.528+10	3.320-01	2.713+11	1.725+03	2.010+00	3.831+00	5.773+10	2.566+10	6.046+05	2.657+05
99	3.564+10	3.314-01	2.734+11	1.740+03	2.013+00	3.839+00	5.833+10	2.592+10	6.064+05	2.670+05
100	3.600+10	3.309-01	2.756+11	1.755+03	2.015+00	3.846+00	5.893+10	2.617+10	6.081+05	2.684+05
101	3.636+10	3.303-01	2.778+11	1.770+03	2.018+00	3.854+00	5.953+10	2.643+10	[illegible]	2.697+05
102	3.672+10	3.297-01	2.799+11	1.785+03	2.021+00	3.862+00	6.013+10	2.669+10	[illegible]	2.711+05
103	3.706+10	3.292-01	2.821+11	1.800+03	2.023+00	3.869+00	6.073+10	2.695+10	[illegible]	2.724+05

TABLE B.3 (Continued)

100 Percent Water (Continued)

104	3.744+10	3.286-01	2.842+11	1.815+03	2.026+00	3.876+00	6.132+10	2.720+10	6.150+05	2.737+05
105	[illegible]	3.281-01	2.864+11	1.830+03	2.029+00	3.884+00	6.192+10	2.746+10	6.167+05	2.750+05
106	[illegible]	3.276-01	2.885+11	1.845+03	2.031+00	3.891+00	6.252+10	2.772+10	6.184+05	2.763+05
107	[illegible]	3.270-01	2.907+11	1.860+03	2.034+00	3.899+00	6.312+10	2.798+10	6.200+05	2.776+05
108	[illegible]	3.265-01	2.928+11	1.875+03	2.036+00	3.906+00	6.372+10	2.823+10	6.217+05	2.789+05
109	3.924+10	3.260-01	2.949+11	1.890+03	2.039+00	3.913+00	6.432+10	2.849+10	6.234+05	2.802+05
110	3.960+10	3.255-01	2.971+11	1.906+03	2.042+00	3.921+00	6.493+10	2.875+10	6.250+05	2.815+05
111	3.996+10	3.250-01	2.992+11	1.921+03	2.044+00	3.928+00	6.553+10	2.900+10	6.266+05	2.828+05
112	4.032+16	3.245-01	3.013+11	1.936+03	2.047+00	3.935+00	6.613+10	2.926+10	6.283+05	2.840+05

TABLE B.4

Sound Speed and Entropy on NTS Tuff and Water Hugoniot

P = Pressure, ergs/cc
C = Sound Speed, cm/sec
S = Entropy, ergs/gm-deg K

NTS Tuff

P	C	S
1.1000+10	3.3624+05	7.5533+03
1.2000+10	3.3761+05	1.0018+04
1.3000+10	3.3896+05	1.2929+04
1.4000+10	3.4033+05	1.6264+04
1.5000+10	3.4166+05	2.0055+04
1.6000+10	3.4297+05	2.4325+04
1.7000+10	3.4427+05	2.9091+04
1.8000+10	3.4556+05	3.4368+04
1.9000+10	3.4684+05	4.0171+04
2.0000+10	3.4810+05	4.6513+04
2.1000+10	3.4935+05	5.3405+04
2.2000+10	3.5058+05	6.0862+04
2.3000+10	3.5181+05	6.8890+04
2.4000+10	3.5302+05	7.7499+04
2.5000+10	3.5423+05	8.6697+04
2.6000+10	3.5542+05	9.6492+04
2.7000+10	3.5660+05	1.0689+05
2.8000+10	3.5777+05	1.1790+05
2.9000+10	3.5893+05	1.2952+05
3.0000+10	3.6007+05	1.4175+05
3.1000+10	3.6121+05	1.5461+05
3.2000+10	3.6234+05	1.6809+05
3.3000+10	3.6346+05	1.8220+05
3.4000+10	3.6457+05	1.9693+05
3.5000+10	3.6567+05	2.1230+05
3.6000+10	3.6675+05	2.2829+05
3.7000+10	3.6784+05	2.4491+05
3.8000+10	3.6891+05	2.6215+05
3.9000+10	3.6998+05	2.8003+05
4.0000+10	3.7103+05	2.9853+05
4.1000+10	3.7208+05	3.1765+05
4.2000+10	3.7312+05	3.3739+05
4.3000+10	3.7415+05	3.5775+05
4.4000+10	3.7517+05	3.7872+05
4.5000+10	3.7619+05	4.0031+05
4.6000+10	3.7720+05	4.2250+05
4.7000+10	3.7820+05	4.4529+05
4.8000+10	3.7919+05	4.6868+05
4.9000+10	3.8017+05	4.9267+05

TABLE B.4 (Continued)

NOT REPRODUCIBLE

P	C	S
5.0000+10	3.8115+05	5.1725+05
5.1000+10	3.8212+05	5.4240+05
5.2000+10	3.8309+05	5.6814+05
5.3000+10	3.8405+05	5.9445+05
5.4000+10	3.8500+05	6.2132+05
5.5000+10	3.8594+05	6.4875+05
5.6000+10	3.8688+05	6.7674+05
5.7000+10	3.8781+05	7.0527+05
5.8000+10	3.8874+05	7.3435+05
5.9000+10	3.8966+05	7.6396+05
6.0000+10	3.9057+05	7.9409+05
6.1000+10	3.9148+05	8.2474+05
6.2000+10	3.9238+05	8.5591+05
6.3000+10	3.9328+05	8.8757+05
6.4000+10	3.9417+05	9.1974+05
6.5000+10	3.9505+05	9.5240+05
6.6000+10	3.9593+05	9.8553+05
6.7000+10	3.9680+05	1.0191+06
6.8000+10	3.9767+05	1.0532+06
6.9000+10	3.9853+05	1.0878+06
7.0000+10	3.9939+05	1.1227+06
7.1000+10	4.0024+05	1.1582+06
7.2000+10	4.0109+05	1.1940+06
7.3000+10	4.0193+05	1.2303+06
7.4000+10	4.0277+05	1.2671+06
7.5000+10	4.0360+05	1.3042+06
7.6000+10	4.0443+05	1.3417+06
7.7000+10	4.0525+05	1.3796+06
7.8000+10	4.0607+05	1.4179+06
7.9000+10	4.0688+05	1.4566+06
8.0000+10	4.0769+05	1.4957+06
8.1000+10	4.0850+05	1.5351+06
8.2000+10	4.0930+05	1.5749+06
8.3000+10	4.1009+05	1.6150+06
8.4000+10	4.1088+05	1.6555+06
8.5000+10	4.1167+05	1.6963+06
8.6000+10	4.1245+05	1.7374+06
8.7000+10	4.1323+05	1.7789+06
8.8000+10	4.1400+05	1.8206+06
8.9000+10	4.1477+05	1.8627+06
9.0000+10	4.1554+05	1.9050+06
9.1000+10	4.1630+05	1.9477+06
9.2000+10	4.1706+05	1.9906+06
9.3000+10	4.1781+05	2.0338+06
9.4000+10	4.1856+05	2.0773+06
9.5000+10	4.1931+05	2.1210+06
9.6000+10	4.2005+05	2.1649+06
9.7000+10	4.2079+05	2.2091+06
9.8000+10	4.2153+05	2.2535+06
9.9000+10	4.2226+05	2.2983+06

TABLE B.4 (Continued)

P	C	S
1.0000+11	4.2298+05	2.3432+06
1.0100+11	4.2371+05	2.3883+06
1.0200+11	4.2443+05	2.4336+06
1.0300+11	4.2515+05	2.4791+06
1.0400+11	4.2586+05	2.5249+06
1.0500+11	4.2657+05	2.5708+06
1.0600+11	4.2728+05	2.6169+06
1.0700+11	4.2798+05	2.6632+06
1.0800+11	4.2869+05	2.7096+06
1.0900+11	4.2938+05	2.7562+06
1.1000+11	4.3007+05	2.8030+06
1.1100+11	4.3076+05	2.8499+06
1.1200+11	4.3145+05	2.8970+06
1.1300+11	4.3214+05	2.9442+06
1.1400+11	4.3282+05	2.9916+06
1.1500+11	4.3349+05	3.0391+06
1.1600+11	4.3417+05	3.0867+06
1.1700+11	4.3484+05	3.1344+06
1.1800+11	4.3551+05	3.1823+06
1.1900+11	4.3618+05	3.2303+06
1.2000+11	4.3551+05	3.1823+06
1.2100+11	4.3750+05	3.3265+06
1.2200+11	4.3815+05	3.3749+06
1.2300+11	4.3881+05	3.4231+06
1.2400+11	4.3946+05	3.4716+06
1.2500+11	4.4011+05	3.5201+06
1.2600+11	4.4076+05	3.5687+06
1.2700+11	4.4140+05	3.6174+06
1.2800+11	4.4204+05	3.6661+06
1.2900+11	4.4268+05	3.7149+06
1.3000+11	4.4332+05	3.7638+06
1.3100+11	4.4395+05	3.8127+06
1.3200+11	4.4458+05	3.8617+06
1.3300+11	4.4521+05	3.9107+06
1.3400+11	4.4583+05	3.9597+06
1.3500+11	4.4646+05	4.0088+06
1.3600+11	4.4708+05	4.0580+06
1.3700+11	4.4769+05	4.1071+06
1.3800+11	4.4831+05	4.1563+06
1.3900+11	4.4892+05	4.2056+06
1.4000+11	4.4953+05	4.2548+06
1.4100+11	4.5014+05	4.3041+06
1.4200+11	4.5075+05	4.3533+06
1.4300+11	4.5135+05	4.4026+06
1.4400+11	4.5195+05	4.4519+06
1.4500+11	4.5255+05	4.5012+06
1.4600+11	4.5314+05	4.5505+06
1.4700+11	4.5374+05	4.5998+06
1.4800+11	4.5433+05	4.6491+06
1.4900+11	4.5492+05	4.6984+06

TABLE B.4 (Continued)

P	C	S
1.5000+11	4.5551+05	4.7477+06
1.5100+11	4.5609+05	4.7970+06
1.5200+11	4.5667+05	4.8462+06
1.5300+11	4.5725+05	4.8955+06
1.5400+11	4.5783+05	4.9447+06
1.5500+11	4.5841+05	4.9939+06
1.5600+11	4.5898+05	5.0431+06
1.5700+11	4.5956+05	5.0922+06
1.5800+11	4.6013+05	5.1413+06
1.5900+11	4.6069+05	5.1904+06
1.6000+11	4.6126+05	5.2395+06
1.6100+11	4.6182+05	5.2885+06
1.6200+11	4.6239+05	5.3375+06
1.6300+11	4.6295+05	5.3864+06
1.6400+11	4.6350+05	5.4353+06
1.6500+11	4.6406+05	5.4841+06
1.6600+11	4.6461+05	5.5329+06
1.6700+11	4.6517+05	5.5817+06
1.6800+11	4.6572+05	5.6304+06
1.6900+11	4.6626+05	5.6791+06
1.7000+11	4.6681+05	5.7277+06
1.7100+11	4.6735+05	5.7762+06
1.7200+11	4.6790+05	5.8247+06
1.7300+11	4.6844+05	5.8732+06
1.7400+11	4.6898+05	5.9216+06
1.7500+11	4.6951+05	5.9699+06
1.7600+11	4.7005+05	6.0181+06
1.7700+11	4.7058+05	6.0663+06
1.7800+11	4.7112+05	6.1144+06
1.7900+11	4.7165+05	6.1625+06
1.8000+11	4.7217+05	6.2105+06
1.8100+11	4.7270+05	6.2584+06
1.8200+11	4.7322+05	6.3063+06
1.8300+11	4.7375+05	6.3541+06
1.8400+11	4.7427+05	6.4018+06
1.8500+11	4.7479+05	6.4494+06
1.8600+11	4.7531+05	6.4970+06
1.8700+11	4.7582+05	6.5445+06
1.8800+11	4.7634+05	6.5919+06
1.8900+11	4.7685+05	6.6392+06
1.9000+11	4.7736+05	6.6865+06
1.9100+11	4.7787+05	6.7336+06
1.9200+11	4.7838+05	6.7807+06
1.9300+11	4.7889+05	6.8277+06
1.9400+11	4.7939+05	6.8747+06
1.9500+11	4.7990+05	6.9215+06
1.9600+11	4.8040+05	6.9683+06
1.9700+11	4.8090+05	7.0150+06
1.9800+11	4.8140+05	7.0616+06
1.9900+11	4.8189+05	7.1081+06

TABLE B.4 (Continued)

P	G	S
2.0000+11	4.8239+05	7.1545+06
2.0100+11	4.8288+05	7.2008+06
2.0200+11	4.8339+05	7.2471+06
2.0300+11	4.8387+05	7.2932+06
2.0400+11	4.8436+05	7.3393+06
2.0500+11	4.8485+05	7.3853+06
2.0600+11	4.8533+05	7.4312+06
2.0700+11	4.8582+05	7.4770+06
2.0800+11	4.8630+05	7.5227+06
2.0900+11	4.8676+05	7.5683+06
2.1000+11	4.8727+05	7.6139+06
2.1100+11	4.8775+05	7.6593+06
2.1200+11	4.8822+05	7.7046+06
2.1300+11	4.8870+05	7.7499+06
2.1400+11	4.8919+05	7.7950+06
2.1500+11	4.8965+05	7.8401+06
2.1600+11	4.9012+05	7.8851+06
2.1700+11	4.9059+05	7.9299+06
2.1800+11	4.9105+05	7.9747+06
2.1900+11	4.9152+05	8.0194+06
2.2000+11	4.9200+05	8.0640+06
2.2100+11	4.9247+05	8.1085+06
2.2200+11	4.9293+05	8.1529+06
2.2300+11	4.9339+05	8.1971+06
2.2400+11	4.9386+05	8.2413+06
2.2500+11	4.9432+05	8.2854+06
2.2600+11	4.9479+05	8.3295+06
2.2700+11	4.9523+05	8.3734+06
2.2800+11	4.9569+05	8.4172+06
2.2900+11	4.9615+05	8.4609+06
2.3000+11	4.9660+05	8.5045+06
2.3100+11	4.9705+05	8.5480+06
2.3200+11	4.9751+05	8.5914+06
2.3300+11	4.9796+05	8.6348+06
2.3400+11	4.9841+05	8.6780+06
2.3500+11	4.9886+05	8.7211+06
2.3600+11	4.9930+05	8.7641+06
2.3700+11	4.9975+05	8.8071+06
2.3800+11	5.0019+05	8.8499+06
2.3900+11	5.0064+05	8.8926+06
2.4000+11	5.0108+05	8.9352+06
2.4100+11	5.0152+05	8.9778+06
2.4200+11	5.0195+05	9.0202+06
2.4300+11	5.0240+05	9.0625+06
2.4400+11	5.0284+05	9.1048+06
2.4500+11	5.0327+05	9.1469+06
2.4600+11	5.0371+05	9.1890+06
2.4700+11	5.0414+05	9.2309+06
2.4800+11	5.0458+05	9.2727+06
2.4900+11	5.0501+05	9.3145+06

TABLE B.4 (Continued)

P	C	S
2.5000+11	5.0544+05	9.3561+06
2.5100+11	5.0587+05	9.3977+06
2.5200+11	5.0630+05	9.4391+06
2.5300+11	5.0672+05	9.4805+06
2.5400+11	5.0715+05	9.5217+06
2.5500+11	5.0758+05	9.5629+06
2.5600+11	5.0800+05	9.6039+06
2.5700+11	5.0842+05	9.6449+06
2.5800+11	5.0885+05	9.6857+06
2.5900+11	5.0927+05	9.7265+06
2.6000+11	5.0969+05	9.7672+06
2.6100+11	5.1011+05	9.8077+06
2.6200+11	5.1052+05	9.8482+06
2.6300+11	5.1094+05	9.8885+06
2.6400+11	5.1135+05	9.9288+06
2.6500+11	5.1177+05	9.9690+06
2.6600+11	5.1218+05	1.0009+07
2.6700+11	5.1260+05	1.0049+07
2.6800+11	5.1301+05	1.0089+07
2.6900+11	5.1342+05	1.0129+07
2.7000+11	5.1383+05	1.0168+07
2.7100+11	5.1424+05	1.0208+07
2.7200+11	5.1465+05	1.0247+07
2.7300+11	5.1505+05	1.0287+07
2.7400+11	5.1546+05	1.0326+07
2.7500+11	5.1586+05	1.0365+07
2.7600+11	5.1627+05	1.0405+07
2.7700+11	5.1667+05	1.0444+07
2.7800+11	5.1707+05	1.0482+07
2.7900+11	5.1747+05	1.0521+07
2.8000+11	5.1787+05	1.0560+07
2.8100+11	5.1827+05	1.0599+07
2.8200+11	5.1867+05	1.0637+07
2.8300+11	5.1907+05	1.0676+07
2.8400+11	5.1946+05	1.0714+07
2.8500+11	5.1986+05	1.0752+07
2.8600+11	5.2025+05	1.0790+07
2.8700+11	5.2065+05	1.0829+07
2.8800+11	5.2104+05	1.0867+07
2.8900+11	5.2143+05	1.0904+07
2.9000+11	5.2182+05	1.0942+07
2.9100+11	5.2221+05	1.0980+07
2.9200+11	5.2260+05	1.1018+07
2.9300+11	5.2299+05	1.1055+07
2.9400+11	5.2338+05	1.1092+07
2.9500+11	5.2376+05	1.1130+07
2.9600+11	5.2415+05	1.1167+07
2.9700+11	5.2453+05	1.1204+07
2.9800+11	5.2492+05	1.1241+07
2.9900+11	5.2530+05	1.1278+07

TABLE B.4 (Continued)

p	C	S
3.0000+11	5.2568+05	1.1315+07
3.0100+11	5.2606+05	1.1352+07
3.0200+11	5.2644+05	1.1389+07
3.0300+11	5.2682+05	1.1425+07
3.0400+11	5.2720+05	1.1462+07
3.0500+11	5.2758+05	1.1498+07
3.0600+11	5.2795+05	1.1535+07
3.0700+11	5.2833+05	1.1571+07
3.0800+11	5.2871+05	1.1607+07
3.0900+11	5.2908+05	1.1643+07
3.1000+11	5.2945+05	1.1679+07
3.1100+11	5.2983+05	1.1715+07
3.1200+11	5.3020+05	1.1751+07
3.1300+11	5.3057+05	1.1787+07
3.1400+11	5.3094+05	1.1822+07
3.1500+11	5.3131+05	1.1858+07
3.1600+11	5.3169+05	1.1893+07
3.1700+11	5.3205+05	1.1929+07
3.1800+11	5.3242+05	1.1964+07
3.1900+11	5.3278+05	1.1999+07
3.2000+11	5.3315+05	1.2034+07
3.2100+11	5.3352+05	1.2069+07
3.2200+11	5.3388+05	1.2104+07
3.2300+11	5.3424+05	1.2139+07
3.2400+11	5.3461+05	1.2174+07
3.2500+11	5.3497+05	1.2209+07
3.2600+11	5.3533+05	1.2243+07
3.2700+11	5.3569+05	1.2278+07
3.2800+11	5.3605+05	1.2312+07
3.2900+11	5.3641+05	1.2347+07
3.3000+11	5.3677+05	1.2381+07
3.3100+11	5.3712+05	1.2415+07
3.3200+11	5.3748+05	1.2449+07
3.3300+11	5.3784+05	1.2483+07
3.3400+11	5.3819+05	1.2517+07
3.3500+11	5.3855+05	1.2551+07
3.3600+11	5.3890+05	1.2585+07
3.3700+11	5.3925+05	1.2619+07
3.3800+11	5.3960+05	1.2652+07
3.3900+11	5.3996+05	1.2686+07
3.4000+11	5.4031+05	1.2719+07
3.4100+11	5.4066+05	1.2753+07
3.4200+11	5.4101+05	1.2786+07
3.4300+11	5.4135+05	1.2819+07
3.4400+11	5.4170+05	1.2852+07
3.4500+11	5.4205+05	1.2885+07
3.4600+11	5.4240+05	1.2918+07
3.4700+11	5.4274+05	1.2951+07
3.4800+11	5.4309+05	1.2984+07
3.4900+11	5.4343+05	1.3017+07
3.5000+11	5.4378+05	1.3050+07
3.5100+11	5.4412+05	1.3082+07

TABLE B.4 (Continued)

Water

$P \times 10^{-9}$	C (cm/sec)	S (ergs/g-deg K)
10.	2.74495+05	7.33694+05
11.	2.82257+05	9.35830+05
12.	2.89533+05	1.08579+06
13.	2.96390+05	1.24275+06
14.	3.02843+05	1.40606+06
15.	3.08902+05	1.57510+06
16.	3.14777+05	1.74937+06
17.	3.20300+05	1.92876+06
18.	3.25571+05	2.11143+06
19.	3.30611+05	2.29844+06
20.	3.35439+05	2.48891+06
21.	3.40069+05	2.68250+06
22.	3.44521+05	2.87323+06
23.	3.48807+05	3.07730+06
24.	3.52937+05	3.27337+06
25.	3.56925+05	3.48217+06
26.	3.60780+05	3.68715+06
27.	3.64510+05	3.89376+06
28.	3.68124+05	4.10175+06
29.	3.71628+05	4.31069+06
30.	3.75031+05	4.52131+06
31.	3.78337+05	4.73257+06
32.	3.81557+05	4.94464+06
33.	3.84692+05	5.15739+06
34.	3.87771+05	5.37070+06
35.	3.90704+05	5.58447+06
36.	3.93604+05	5.79861+06
37.	3.96435+05	6.01301+06
38.	3.99207+05	6.22761+06
39.	4.0192[illegible]+05	6.44271+06
40.	4.04562+05	6.65705+06
41.	4.07141+05	6.87177+06
42.	4.09677+05	7.08640+06
43.	4.12162+05	7.30087+06
44.	4.14603+05	7.51515+06
45.	4.16987+05	7.72918+06
46.	4.19331+05	7.94297+06
47.	4.21633+05	8.15631+06
48.	4.23893+05	8.36934+06
49.	4.26115+05	8.58194+06
50.	4.28299+05	8.79411+06
51.	4.30445+05	9.00579+06
52.	4.32553+05	9.21693+06
53.	4.34632+05	9.42752+06
54.	4.36684+05	9.63777+06
55.	4.38699+05	9.84723+06
56.	4.40695+05	1.00561+07
57.	4.42643+05	1.02644+07
58.	4.44571+05	1.04721+07
59.	4.46473+05	1.06791+07

TABLE B.4 (Continued)

P	C	S
5.0000+10	4.2823+05	5.8790+06
5.1000+10	4.3039+05	9.0905+06
5.2000+10	4.3250+05	9.3015+06
5.3000+10	4.3450+05	9.5119+06
5.4000+10	4.3654+05	9.7217+06
5.5000+10	4.3855+05	9.9309+06
5.6000+10	4.4055+05	1.0139+07
5.7000+10	4.4251+05	1.0347+07
5.8000+10	4.4455+05	1.0555+07
5.9000+10	4.4646+05	1.0761+07
6.0000+10	4.4835+05	1.0968+07
6.1000+10	4.5021+05	1.1174+07
6.2000+10	4.5204+05	1.1379+07
6.3000+10	4.5385+05	1.1583+07
6.4000+10	4.5564+05	1.1786+07
6.5000+10	4.5740+05	1.1988+07
6.6000+10	4.5915+05	1.2190+07
6.7000+10	4.6087+05	1.2391+07
6.8000+10	4.6257+05	1.2591+07
6.9000+10	4.6425+05	1.2791+07
7.0000+10	4.6592+05	1.2989+07
7.1000+10	4.6757+05	1.3187+07
7.2000+10	4.6920+05	1.3384+07
7.3000+10	4.7081+05	1.3581+07
7.4000+10	4.7241+05	1.3776+07
7.5000+10	4.7399+05	1.3971+07
7.6000+10	4.7555+05	1.4165+07
7.7000+10	4.7710+05	1.4359+07
7.8000+10	4.7864+05	1.4551+07
7.9000+10	4.8016+05	1.4742+07
8.0000+10	4.8166+05	1.4933+07
8.1000+10	4.8315+05	1.5124+07
8.2000+10	4.8463+05	1.5313+07
8.3000+10	4.8610+05	1.5501+07
8.4000+10	4.8755+05	1.5689+07
8.5000+10	4.8899+05	1.5876+07
8.6000+10	4.9042+05	1.6062+07
8.7000+10	4.9184+05	1.6248+07
8.8000+10	4.9324+05	1.6432+07
8.9000+10	4.9464+05	1.6616+07
9.0000+10	4.9602+05	1.6799+07
9.1000+10	4.9739+05	1.6982+07
9.2000+10	4.9876+05	1.7163+07
9.3000+10	5.0011+05	1.7344+07
9.4000+10	5.0145+05	1.7524+07
9.5000+10	5.0278+05	1.7703+07
9.6000+10	5.0411+05	1.7882+07
9.7000+10	5.0542+05	1.8060+07
9.8000+10	5.0672+05	1.8237+07
9.9000+10	5.0802+05	1.8413+07

TABLE B.4 (Continued)

P_t	C	S
1.0000+11	5.0931+05	1.8588+07
1.0100+11	5.1059+05	1.8763+07
1.0200+11	5.1186+05	1.8937+07
1.0300+11	5.1312+05	1.9111+07
1.0400+11	5.1437+05	1.9283+07
1.0500+11	5.1562+05	1.9455+07
1.0600+11	5.1686+05	1.9626+07
1.0700+11	5.1809+05	1.9796+07
1.0800+11	5.1931+05	1.9965+07
1.0900+11	5.2053+05	2.0135+07
1.1000+11	5.2174+05	2.0303+07
1.1100+11	5.2294+05	2.0471+07
1.1200+11	5.2413+05	2.0638+07
1.1300+11	5.2532+05	2.0804+07
1.1400+11	5.2650+05	2.0969+07
1.1500+11	5.2768+05	2.1134+07
1.1600+11	5.2885+05	2.1298+07
1.1700+11	5.3001+05	2.1461+07
1.1800+11	5.3117+05	2.1624+07
1.1900+11	5.3232+05	2.1786+07
1.2000+11	5.3347+05	2.1948+07
1.2100+11	5.3461+05	2.2108+07
1.2200+11	5.3574+05	2.2268+07
1.2300+11	5.3687+05	2.2428+07
1.2400+11	5.3799+05	2.2586+07
1.2500+11	5.3911+05	2.2744+07
1.2600+11	5.4022+05	2.2902+07
1.2700+11	5.4133+05	2.3059+07
1.2800+11	5.4243+05	2.3215+07
1.2900+11	5.4352+05	2.3370+07
1.3000+11	5.4461+05	2.3525+07
1.3100+11	5.4570+05	2.3679+07
1.3200+11	5.4678+05	2.3833+07
1.3300+11	5.4786+05	2.3986+07
1.3400+11	5.4893+05	2.4139+07
1.3500+11	5.5000+05	2.4290+07
1.3600+11	5.5106+05	2.4441+07
1.3700+11	5.5212+05	2.4592+07
1.3800+11	5.5318+05	2.4742+07
1.3900+11	5.5423+05	2.4891+07
1.4000+11	5.5527+05	2.5040+07
1.4100+11	5.5631+05	2.5188+07
1.4200+11	5.5735+05	2.5336+07
1.4300+11	5.5838+05	2.5483+07
1.4400+11	5.5941+05	2.5630+07
1.4500+11	5.6044+05	2.5775+07
1.4600+11	5.6146+05	2.5921+07
1.4700+11	5.6248+05	2.6066+07
1.4800+11	5.6349+05	2.6210+07
1.4900+11	5.6450+05	2.6353+07

TABLE B.4 (Continued)

P	C	S
1.5000+11	5.6551+05	2.6497+07
1.5100+11	5.6651+05	2.6639+07
1.5200+11	5.6751+05	2.6781+07
1.5300+11	5.6855+05	2.6922+07
1.5400+11	5.6958+05	2.7063+07
1.5500+11	5.7049+05	2.7204+07
1.5600+11	5.7147+05	2.7344+07
1.5700+11	5.7245+05	2.7483+07
1.5800+11	5.7343+05	2.7622+07
1.5900+11	5.7440+05	2.7760+07
1.6000+11	5.7538+05	2.7898+07
1.6100+11	5.7634+05	2.8035+07
1.6200+11	5.7731+05	2.8172+07
1.6300+11	5.7827+05	2.8308+07
1.6400+11	5.7923+05	2.8444+07
1.6500+11	5.8019+05	2.8579+07
1.6600+11	5.8114+05	2.8714+07
1.6700+11	5.8209+05	2.8848+07
1.6800+11	5.8304+05	2.8981+07
1.6900+11	5.8398+05	2.9115+07
1.7000+11	5.8492+05	2.9247+07
1.7100+11	5.8586+05	2.9380+07
1.7200+11	5.8680+05	2.9512+07
1.7300+11	5.8773+05	2.9643+07
1.7400+11	5.8866+05	2.9774+07
1.7500+11	5.8959+05	2.9904+07
1.7600+11	5.9051+05	3.0034+07
1.7700+11	5.9143+05	3.0163+07
1.7800+11	5.9235+05	3.0292+07
1.7900+11	5.9327+05	3.0421+07
1.8000+11	5.9419+05	3.0549+07
1.8100+11	5.9510+05	3.0677+07
1.8200+11	5.9600+05	3.0804+07
1.8300+11	5.9691+05	3.0930+07
1.8400+11	5.9781+05	3.1057+07
1.8500+11	5.9871+05	3.1182+07
1.8600+11	5.9961+05	3.1308+07
1.8700+11	6.0051+05	3.1433+07
1.8800+11	6.0140+05	3.1557+07
1.8900+11	6.0229+05	3.1681+07
1.9000+11	6.0318+05	3.1805+07
1.9100+11	6.0407+05	3.1928+07
1.9200+11	6.0495+05	3.2051+07
1.9300+11	6.0583+05	3.2174+07
1.9400+11	6.0671+05	3.2296+07
1.9500+11	6.0758+05	3.2417+07
1.9600+11	6.0847+05	3.2538+07
1.9700+11	6.0934+05	3.2658+07
1.9800+11	6.1021+05	3.2778+07
1.9900+11	6.1108+05	3.2898+07

TABLE B.4 (Continued)

P	C	S
2.0000+11	6.1195+05	3.3019+07
2.0100+11	6.1281+05	3.3138+07
2.0200+11	6.1367+05	3.3257+07
2.0300+11	6.1454+05	3.3375+07
2.0400+11	6.1539+05	3.3493+07
2.0500+11	6.1625+05	3.3611+07
2.0600+11	6.1710+05	3.3728+07
2.0700+11	6.1796+05	3.3845+07
2.0800+11	6.1881+05	3.3961+07
2.0900+11	6.1965+05	3.4077+07
2.1000+11	6.2050+05	3.4193+07
2.1100+11	6.2135+05	3.4308+07
2.1200+11	6.2219+05	3.4423+07
2.1300+11	6.2303+05	3.4537+07
2.1400+11	6.2387+05	3.4652+07
2.1500+11	6.2470+05	3.4765+07
2.1600+11	6.2554+05	3.4879+07
2.1700+11	6.2637+05	3.4992+07
2.1800+11	6.2720+05	3.5105+07
2.1900+11	6.2803+05	3.5217+07
2.2000+11	6.2886+05	3.5329+07
2.2100+11	6.2969+05	3.5441+07
2.2200+11	6.3051+05	3.5552+07
2.2300+11	6.3133+05	3.5663+07
2.2400+11	6.3215+05	3.5774+07
2.2500+11	6.3297+05	3.5884+07
2.2600+11	6.3379+05	3.5994+07
2.2700+11	6.3460+05	3.6103+07
2.2800+11	6.3541+05	3.6213+07
2.2900+11	6.3622+05	3.6321+07
2.3000+11	6.3703+05	3.6430+07
2.3100+11	6.3784+05	3.6538+07
2.3200+11	6.3865+05	3.6646+07
2.3300+11	6.3945+05	3.6754+07
2.3400+11	6.4025+05	3.6861+07
2.3500+11	6.4105+05	3.6968+07
2.3600+11	6.4185+05	3.7075+07
2.3700+11	6.4265+05	3.7181+07
2.3800+11	6.4345+05	3.7287+07
2.3900+11	6.4425+05	3.7392+07
2.4000+11	6.4504+05	3.7498+07
2.4100+11	6.4583+05	3.7603+07
2.4200+11	6.4662+05	3.7707+07
2.4300+11	6.4741+05	3.7812+07
2.4400+11	6.4820+05	3.7916+07
2.4500+11	6.4898+05	3.8020+07
2.4600+11	6.4977+05	3.8123+07
2.4700+11	6.5055+05	3.8226+07
2.4800+11	6.5133+05	3.8329+07
2.4900+11	6.5211+05	3.8432+07

TABLE B.4 (Continued)

NOT REPRODUCIBLE

P	C	S
2.5000+11	6.5283+05	3.8534+07
2.5100+11	6.5367+05	3.8636+07
2.5200+11	6.5444+05	3.8738+07
2.5300+11	6.5522+05	3.8839+07
2.5400+11	6.5600+05	3.8940+07
2.5500+11	6.5676+05	3.9041+07
2.5600+11	6.5757+05	3.9141+07
2.5700+11	6.5830+05	3.9242+07
2.5800+11	6.5906+05	3.9342+07
2.5900+11	6.5987+05	3.9441+07
2.6000+11	6.6059+05	3.9541+07
2.6100+11	6.6135+05	3.9640+07
2.6200+11	6.6211+05	3.9739+07
2.6300+11	6.6287+05	3.9837+07
2.6400+11	6.6363+05	3.9935+07
2.6500+11	6.6439+05	4.0033+07
2.6600+11	6.6514+05	4.0131+07
2.6700+11	6.6590+05	4.0228+07
2.6800+11	6.6665+05	4.0326+07
2.6900+11	6.6740+05	4.0423+07
2.7000+11	6.6815+05	4.0519+07
2.7100+11	6.6890+05	4.0615+07
2.7200+11	6.6965+05	4.0712+07
2.7300+11	6.7039+05	4.0807+07
2.7400+11	6.7114+05	4.0903+07
2.7500+11	6.7188+05	4.0998+07
2.7600+11	6.7262+05	4.1093+07
2.7700+11	6.7337+05	4.1188+07
2.7800+11	6.7411+05	4.1283+07
2.7900+11	6.7484+05	4.1377+07
2.8000+11	6.7558+05	4.1471+07
2.8100+11	6.7632+05	4.1565+07
2.8200+11	6.7705+05	4.1659+07
2.8300+11	6.7778+05	4.1752+07
2.8400+11	6.7852+05	4.1845+07
2.8500+11	6.7925+05	4.1937+07
2.8600+11	6.7998+05	4.2030+07
2.8700+11	6.8071+05	4.2122+07
2.8800+11	6.8143+05	4.2214+07
2.8900+11	6.8216+05	4.2306+07
2.9000+11	6.8288+05	4.2398+07
2.9100+11	6.8361+05	4.2489+07
2.9200+11	6.8433+05	4.2580+07
2.9300+11	6.8505+05	4.2671+07
2.9400+11	6.8577+05	4.2761+07
2.9500+11	6.8649+05	4.2852+07
2.9600+11	6.8721+05	4.2942+07
2.9700+11	6.8792+05	4.3032+07
2.9800+11	6.8864+05	4.3121+07
2.9900+11	6.8935+05	4.3211+07

TABLE B.4 (Continued)

P	C	S
3.0000+11	6.9007+05	4.3300+07
3.0100+11	6.9079+05	4.3389+07
3.0200+11	6.9149+05	4.3478+07
3.0300+11	6.9220+05	4.3566+07
3.0400+11	6.9291+05	4.3655+07
3.0500+11	6.9361+05	4.3743+07
3.0600+11	6.9432+05	4.3831+07
3.0700+11	6.9503+05	4.3918+07
3.0800+11	6.9573+05	4.4006+07
3.0900+11	6.9643+05	4.4093+07
3.1000+11	6.9713+05	4.4180+07
3.1100+11	6.9783+05	4.4267+07
3.1200+11	6.9853+05	4.4353+07
3.1300+11	6.9923+05	4.4439+07
3.1400+11	6.9993+05	4.4525+07
3.1500+11	7.0063+05	4.4611+07
3.1600+11	7.0132+05	4.4697+07
3.1700+11	7.0202+05	4.4783+07
3.1800+11	7.0271+05	4.4868+07
3.1900+11	7.0340+05	4.4953+07
3.2000+11	7.0409+05	4.5038+07
3.2100+11	7.0478+05	4.5122+07
3.2200+11	7.0547+05	4.5207+07
3.2300+11	7.0616+05	4.5291+07
3.2400+11	7.0684+05	4.5375+07
3.2500+11	7.0753+05	4.5459+07
3.2600+11	7.0822+05	4.5543+07
3.2700+11	7.0890+05	4.5626+07
3.2800+11	7.0958+05	4.5709+07
3.2900+11	7.1026+05	4.5792+07
3.3000+11	7.1094+05	4.5875+07
3.3100+11	7.1162+05	4.5958+07
3.3200+11	7.1230+05	4.6040+07
3.3300+11	7.1298+05	4.6122+07
3.3400+11	7.1365+05	4.6204+07
3.3500+11	7.1433+05	4.6286+07
3.3600+11	7.1501+05	4.6368+07
3.3700+11	7.1568+05	4.6449+07
3.3800+11	7.1635+05	4.6531+07
3.3900+11	7.1702+05	4.6612+07
3.4000+11	7.1769+05	4.6693+07
3.4100+11	7.1836+05	4.6773+07
3.4200+11	7.1903+05	4.6854+07
3.4300+11	7.1970+05	4.6934+07
3.4400+11	7.2037+05	4.7014+07
3.4500+11	7.2103+05	4.7094+07
3.4600+11	7.2170+05	4.7174+07
3.4700+11	7.2236+05	4.7254+07
3.4800+11	7.2302+05	4.7333+07
3.4900+11	7.2369+05	4.7412+07
3.5000+11	7.2435+05	4.7491+07
3.5100+11	7.2501+05	4.7570+07

TABLE B.5

Initially Porous PTEQ Hugoniots for Complete Void Collapse

M_W = 0, .05, .15, .25, 1.0 - $n_0^{(3)}$ = .05, .10, .15, .20

AIX = Energy of Mix, ergs/g
TVOL = Specific Volume of Mix, cc/g
P = Pressure, ergs/cc
Theta = Temperature, °K
Rho Water = Density of Water, g/cc
Rho Tuff = Density of Tuff, g/cc
SIE Water = Energy of Water, ergs/g
SIE Tuff = Energy of Tuff, ergs/g
Shock Vel = Shock Velocity, U, cm/sec
Part. Vel = Particle Velocity, u, cm/sec

.00 PERCENT WATER, 20 PERCENT POROSITY MIXTURE (M_W = 0, Initially Porous $\overline{\text{NTS}}$ Tuff)

K	AIX	TVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	4.069-01	6.320+09	3.348+02	9.982-01	2.457+00	3.600+08	3.600+08	1.227+05	2.683+04
2	7.200+08	3.992-01	1.183+10	3.717+02	9.982-01	2.505+00	7.200+08	7.200+08	1.624+05	3.793+04
3	1.080+09	3.927-01	1.685+10	4.057+02	9.982-01	2.546+00	1.080+09	1.080+09	1.889+05	4.645+04
4	1.440+09	3.871-01	2.152+10	4.378+02	9.982-01	2.583+00	1.440+09	1.440+09	2.089+05	5.364+04
5	1.800+09	3.821-01	2.593+10	4.685+02	9.982-01	2.617+00	1.800+09	1.800+09	2.251+05	5.998+04
6	2.160+09	3.776-01	3.013+10	4.983+02	9.982-01	2.649+00	2.160+09	2.160+09	2.388+05	6.570+04
7	2.520+09	3.734-01	3.417+10	5.272+02	9.982-01	2.678+00	2.520+09	2.520+09	2.506+05	7.097+04
8	2.880+09	3.696-01	3.807+10	5.556+02	9.982-01	2.706+00	2.880+09	2.880+09	2.613+05	7.587+04
9	3.240+09	3.661-01	4.185+10	5.835+02	9.982-01	2.732+00	3.240+09	3.240+09	2.708+05	8.048+04
10	3.600+09	3.628-01	4.553+10	6.110+02	9.982-01	2.757+00	3.600+09	3.600+09	2.795+05	8.483+04
11	3.960+09	3.597-01	4.912+10	6.383+02	9.982-01	2.780+00	3.960+09	3.960+09	2.875+05	8.898+04
12	4.320+09	3.567-01	5.263+10	6.652+02	9.982-01	2.803+00	4.320+09	4.320+09	2.949+05	9.293+04
13	4.680+09	3.540-01	5.607+10	6.919+02	9.982-01	2.825+00	4.680+09	4.680+09	3.019+05	9.673+04
14	5.040+09	3.515-01	5.924+10	7.196+02	9.982-01	2.845+00	5.040+09	5.040+09	3.080+05	1.002+05
15	5.400+09	3.488-01	6.276+10	7.449+02	9.982-01	2.867+00	5.400+09	5.400+09	3.146+05	1.039+05
16	5.760+09	3.466-01	6.583+10	7.724+02	9.982-01	2.885+00	5.760+09	5.760+09	3.201+05	1.071+05
17	6.120+09	3.443-01	6.902+10	7.987+02	9.982-01	2.904+00	6.120+09	6.120+09	3.257+05	1.104+05
18	6.480+09	3.421-01	7.219+10	8.249+02	9.982-01	2.923+00	6.480+09	6.480+09	3.310+05	1.136+05
19	6.840+09	3.400-01	7.532+10	8.509+02	9.982-01	2.941+00	6.840+09	6.840+09	3.361+05	1.167+05
20	7.200+09	3.379-01	7.842+10	8.769+02	9.982-01	2.959+00	7.200+09	7.200+09	3.410+05	1.198+05
21	7.560+09	3.360-01	8.148+10	9.028+02	9.982-01	2.976+00	7.560+09	7.560+09	3.458+05	1.227+05
22	7.920+09	3.341-01	8.451+10	9.287+02	9.982-01	2.993+00	7.920+09	7.920+09	3.504+05	1.256+05
23	8.280+09	3.322-01	8.750+10	9.545+02	9.982-01	3.010+00	8.280+09	8.280+09	3.548+05	1.285+05
24	8.640+09	3.305-01	9.047+10	9.804+02	9.982-01	3.026+00	8.640+09	8.640+09	3.590+05	1.312+05
25	9.000+09	3.287-01	9.341+10	1.006+03	9.982-01	3.042+00	9.000+09	9.000+09	3.632+05	1.340+05
26	9.360+09	3.271-01	9.632+10	1.032+03	9.982-01	3.057+00	9.360+09	9.360+09	3.672+05	1.366+05
27	9.720+09	3.255-01	9.921+10	1.058+03	9.982-01	3.073+00	9.720+09	9.720+09	3.711+05	1.392+05
28	1.008+10	3.239-01	1.021+11	1.084+03	9.982-01	3.088+00	1.008+10	1.008+10	3.750+05	1.418+05
29	1.044+10	3.224-01	1.049+11	1.109+03	9.982-01	3.102+00	1.044+10	1.044+10	3.787+05	1.443+05
30	1.080+10	3.209-01	1.077+11	1.135+03	9.982-01	3.117+00	1.080+10	1.080+10	3.823+05	1.468+05
31	1.116+10	3.194-01	1.105+11	1.161+03	9.982-01	3.131+00	1.116+10	1.116+10	3.858+05	1.492+05
32	1.152+10	3.180-01	1.133+11	1.187+03	9.982-01	3.145+00	1.152+10	1.152+10	3.893+05	1.516+05
33	1.188+10	3.166-01	1.161+11	1.213+03	9.982-01	3.158+00	1.188+10	1.188+10	3.927+05	1.540+05
34	1.224+10	3.153-01	1.188+11	1.239+03	9.982-01	3.172+00	1.224+10	1.224+10	3.960+05	1.563+05
35	1.260+10	3.140-01	1.215+11	1.264+03	9.982-01	3.185+00	1.260+10	1.260+10	3.992+05	1.586+05
36	1.296+10	3.127-01	1.243+11	1.290+03	9.982-01	3.198+00	1.296+10	1.296+10	4.024+05	1.608+05
37	1.332+10	3.114-01	1.270+11	1.316+03	9.982-01	3.211+00	1.332+10	1.332+10	4.055+05	1.630+05
38	1.368+10	3.102-01	1.296+11	1.342+03	9.982-01	3.224+00	1.368+10	1.368+10	4.086+05	1.652+05
39	1.404+10	3.090-01	1.323+11	1.368+03	9.982-01	3.236+00	1.404+10	1.404+10	4.116+05	1.674+05
40	1.440+10	3.078-01	1.350+11	1.394+03	9.982-01	3.248+00	1.440+10	1.440+10	4.146+05	1.695+05
41	1.476+10	3.067-01	1.376+11	1.420+03	9.982-01	3.261+00	1.476+10	1.476+10	4.175+05	1.717+05
42	1.512+10	3.056-01	1.402+11	1.446+03	9.982-01	3.273+00	1.512+10	1.512+10	4.204+05	1.737+05

TABLE B.5 (Continued)

.00 Percent Water, 20 Percent Porosity Mixture (Continued)

43	1.548+10	3.045-01	1.428+11	1.472+03	9.982-01	3.289+00	1.548+10	1.548+10	4.232+05	1.758+05
44	1.584+10	3.034-01	1.454+11	1.498+03	9.982-01	3.298+00	1.584+10	1.584+10	4.259+05	1.778+05
45	1.620+10	3.023-01	1.480+11	1.525+03	9.982-01	3.308+00	1.620+10	1.620+10	4.287+05	1.798+05
46	1.656+10	3.013-01	1.506+11	1.551+03	9.982-01	3.319+00	1.656+10	1.656+10	4.314+05	1.818+05
47	1.692+10	3.003-01	1.532+11	1.577+03	9.982-01	3.330+00	1.692+10	1.692+10	4.340+05	1.838+05
48	1.728+10	2.993-01	1.557+11	1.603+03	9.982-01	3.342+00	1.728+10	1.728+10	4.366+05	1.858+05
49	1.764+10	2.983-01	1.583+11	1.629+03	9.982-01	3.353+00	1.764+10	1.764+10	4.392+05	1.877+05
50	1.800+10	2.973-01	1.608+11	1.656+03	9.982-01	3.364+00	1.800+10	1.800+10	4.417+05	1.896+05
51	1.836+10	2.963-01	1.633+11	1.682+03	9.982-01	3.374+00	1.836+10	1.836+10	4.443+05	1.915+05
52	1.872+10	2.954-01	1.658+11	1.708+03	9.982-01	3.385+00	1.872+10	1.872+10	4.467+05	1.934+05
53	1.908+10	2.945-01	1.683+11	1.735+03	9.982-01	3.396+00	1.908+10	1.908+10	4.492+05	1.952+05
54	1.944+10	2.936-01	1.708+11	1.761+03	9.982-01	3.406+00	1.944+10	1.944+10	4.516+05	1.970+05
55	1.980+10	2.927-01	1.733+11	1.788+03	9.982-01	3.417+00	1.980+10	1.980+10	4.540+05	1.989+05
56	2.016+10	2.918-01	1.758+11	1.814+03	9.982-01	3.427+00	2.016+10	2.016+10	4.563+05	2.007+05
57	2.052+10	2.910-01	1.783+11	1.841+03	9.982-01	3.437+00	2.052+10	2.052+10	4.587+05	2.024+05
58	2.088+10	2.901-01	1.808+11	1.867+03	9.982-01	3.447+00	2.088+10	2.088+10	4.610+05	2.042+05
59	2.124+10	2.893-01	1.832+11	1.894+03	9.982-01	3.457+00	2.124+10	2.124+10	4.633+05	2.060+05
60	2.160+10	2.884-01	1.857+11	1.921+03	9.982-01	3.467+00	2.160+10	2.160+10	4.655+05	2.077+05
61	2.196+10	2.876-01	1.881+11	1.947+03	9.982-01	3.477+00	2.196+10	2.196+10	4.678+05	2.094+05
62	2.232+10	2.868-01	1.905+11	1.974+03	9.982-01	3.486+00	2.232+10	2.232+10	4.700+05	2.112+05
63	2.268+10	2.860-01	1.930+11	2.001+03	9.982-01	3.496+00	2.268+10	2.268+10	4.722+05	2.129+05
64	2.304+10	2.853-01	1.954+11	2.027+03	9.982-01	3.506+00	2.304+10	2.304+10	4.743+05	2.145+05
65	2.340+10	2.845-01	1.978+11	2.054+03	9.982-01	3.515+00	2.340+10	2.340+10	4.765+05	2.162+05
66	2.376+10	2.837-01	2.002+11	2.081+03	9.982-01	3.524+00	2.376+10	2.376+10	4.786+05	2.179+05
67	2.412+10	2.830-01	2.026+11	2.108+03	9.982-01	3.534+00	2.412+10	2.412+10	4.807+05	2.195+05
68	2.448+10	2.823-01	2.050+11	2.135+03	9.982-01	3.543+00	2.448+10	2.448+10	4.828+05	2.211+05
69	2.484+10	2.815-01	2.074+11	2.162+03	9.982-01	3.552+00	2.484+10	2.484+10	4.848+05	2.228+05
70	2.520+10	2.808-01	2.098+11	2.189+03	9.982-01	3.561+00	2.520+10	2.520+10	4.869+05	2.244+05
71	2.556+10	2.801-01	2.121+11	2.216+03	9.982-01	3.570+00	2.556+10	2.556+10	4.887+05	2.260+05
72	2.592+10	2.794-01	2.145+11	2.243+03	9.982-01	3.579+00	2.592+10	2.592+10	4.909+05	2.276+05
73	2.628+10	2.787-01	2.169+11	2.270+03	9.982-01	3.588+00	2.628+10	2.628+10	4.929+05	2.291+05
74	2.664+10	2.780-01	2.192+11	2.297+03	9.982-01	3.597+00	2.664+10	2.664+10	4.949+05	2.307+05
75	2.700+10	2.774-01	2.216+11	2.324+03	9.982-01	3.605+00	2.700+10	2.700+10	4.969+05	2.323+05
76	2.736+10	2.767-01	2.239+11	2.351+03	9.982-01	3.614+00	2.736+10	2.736+10	4.988+05	2.338+05
77	2.772+10	2.760-01	2.263+11	2.378+03	9.982-01	3.623+00	2.772+10	2.772+10	5.007+05	2.353+05
78	2.808+10	2.754-01	2.286+11	2.406+03	9.982-01	3.631+00	2.808+10	2.808+10	5.026+05	2.369+05
79	2.844+10	2.748-01	2.309+11	2.433+03	9.982-01	3.640+00	2.844+10	2.844+10	5.045+05	2.384+05
80	2.880+10	2.741-01	2.333+11	2.460+03	9.982-01	3.648+00	2.880+10	2.880+10	5.064+05	2.399+05
81	2.916+10	2.735-01	2.356+11	2.488+03	9.982-01	3.656+00	2.916+10	2.916+10	5.083+05	2.414+05
82	2.952+10	2.729-01	2.379+11	2.515+03	9.982-01	3.665+00	2.952+10	2.952+10	5.101+05	2.429+05
83	2.988+10	2.723-01	2.402+11	2.542+03	9.982-01	3.673+00	2.988+10	2.988+10	5.120+05	2.443+05
84	3.024+10	2.717-01	2.425+11	2.570+03	9.982-01	3.681+00	3.024+10	3.024+10	5.138+05	2.458+05
85	3.060+10	2.711-01	2.448+11	2.597+03	9.982-01	3.689+00	3.060+10	3.060+10	5.156+05	2.473+05
86	3.096+10	2.705-01	2.471+11	2.625+03	9.982-01	3.697+00	3.096+10	3.096+10	5.174+05	2.487+05
87	3.132+10	2.699-01	2.494+11	2.652+03	9.982-01	3.705+00	3.132+10	3.132+10	5.192+05	2.502+05
88	3.168+10	2.693-01	2.517+11	2.680+03	9.982-01	3.713+00	3.168+10	3.168+10	5.210+05	2.516+05
89	3.204+10	2.687-01	2.540+11	2.707+03	9.982-01	3.721+00	3.204+10	3.204+10	5.228+05	2.530+05
90	3.240+10	2.682-01	2.562+11	2.735+03	9.982-01	3.729+00	3.240+10	3.240+10	5.245+05	2.545+05
91	3.276+10	2.676-01	2.585+11	2.763+03	9.982-01	3.737+00	3.276+10	3.276+10	5.263+05	2.559+05
92	3.312+10	2.670-01	2.608+11	2.790+03	9.982-01	3.745+00	3.312+10	3.312+10	5.280+05	2.573+05
93	3.348+10	2.665-01	2.631+11	2.818+03	9.982-01	3.752+00	3.348+10	3.348+10	5.297+05	2.587+05
94	3.384+10	2.660-01	2.653+11	2.846+03	9.982-01	3.760+00	3.384+10	3.384+10	5.314+05	2.601+05

TABLE B.5 (Continued)

.00 Percent Water, 20 Percent Porosity Mixture (Continued)

95	3.420+10	2.654-01	2.676+11	2.874+03	9.982-01	3.768+00	3.420+10	3.420+10	5.331+05	2.614+05
96	3.456+10	2.649-01	2.698+11	2.902+03	9.982-01	3.775+00	3.456+10	3.456+10	5.348+05	2.628+05
97	3.492+10	2.644-01	2.721+11	2.929+03	9.982-01	3.783+00	3.492+10	3.492+10	5.365+05	2.642+05
98	3.528+10	2.638-01	2.743+11	2.957+03	9.982-01	3.790+00	3.528+10	3.528+10	5.381+05	2.655+05
99	3.564+10	2.633-01	2.766+11	2.985+03	9.982-01	3.798+00	3.564+10	3.564+10	5.398+05	2.669+05
100	3.600+10	2.628-01	2.788+11	3.013+03	9.982-01	3.805+00	3.600+10	3.600+10	5.414+05	2.682+05
101	3.636+10	2.623-01	2.811+11	3.041+03	9.982-01	3.812+00	3.636+10	3.636+10	5.431+05	2.696+05
102	3.672+10	2.618-01	2.833+11	3.069+03	9.982-01	3.820+00	3.672+10	3.672+10	5.447+05	2.709+05
103	3.708+10	2.613-01	2.855+11	3.097+03	9.982-01	3.827+00	3.708+10	3.708+10	5.463+05	2.722+05
104	3.744+10	2.608-01	2.878+11	3.125+03	9.982-01	3.834+00	3.744+10	3.744+10	5.479+05	2.735+05
105	3.780+10	2.603-01	2.900+11	3.153+03	9.982-01	3.842+00	3.780+10	3.780+10	5.495+05	2.749+05
106	3.816+10	2.598-01	2.922+11	3.182+03	9.982-01	3.849+00	3.816+10	3.816+10	5.511+05	2.762+05
107	3.852+10	2.593-01	2.944+11	3.210+03	9.982-01	3.856+00	3.852+10	3.852+10	5.527+05	2.775+05
108	3.888+10	2.589-01	2.966+11	3.238+03	9.982-01	3.863+00	3.888+10	3.888+10	5.542+05	2.788+05
109	3.924+10	2.584-01	2.988+11	3.266+03	9.982-01	3.870+00	3.924+10	3.924+10	5.558+05	2.800+05
110	[illegible]	2.579-01	3.011+11	3.294+03	9.982-01	3.877+00	3.960+10	3.960+10	5.574+05	2.813+05

TABLE B.5 (Continued)

.00 PERCENT WATER, 15 PERCENT POROSITY MIXTURE

K	AIR	TVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	4.038-01	8.375+09	3.329+02	9.982-01	2.476+00	3.600+08	3.600+08	1.526+05	2.690+04
2	7.200+08	3.947-01	1.507+10	3.658+02	9.982-01	2.533+00	7.200+08	7.200+08	1.948+05	3.794+04
3	1.080+09	3.874-01	2.099+10	3.954+02	9.982-01	2.582+00	1.080+09	1.080+09	2.215+05	4.646+04
4	1.440+09	3.812-01	2.639+10	4.230+02	9.982-01	2.624+00	1.440+09	1.440+09	2.412+05	5.364+04
5	1.800+09	3.757-01	3.143+10	4.493+02	9.982-01	2.661+00	1.800+09	1.800+09	2.569+05	5.998+04
6	2.160+09	3.709-01	3.619+10	4.748+02	9.982-01	2.696+00	2.160+09	2.160+09	2.700+05	6.570+04
7	2.520+09	3.665-01	4.073+10	4.996+02	9.982-01	2.728+00	2.520+09	2.520+09	2.813+05	7.097+04
8	2.880+09	3.625-01	4.510+10	5.240+02	9.982-01	2.758+00	2.880+09	2.880+09	2.914+05	7.587+04
9	3.240+09	3.589-01	4.931+10	5.480+02	9.982-01	2.787+00	3.240+09	3.240+09	3.004+05	8.048+04
10	3.600+09	3.554-01	5.340+10	5.717+02	9.982-01	2.813+00	3.600+09	3.600+09	3.084+05	8.483+04
11	3.960+09	3.522-01	5.738+10	5.953+02	9.982-01	2.839+00	3.960+09	3.960+09	3.161+05	8.897+04
12	4.320+09	3.492-01	6.126+10	6.186+02	9.982-01	2.864+00	4.320+09	4.320+09	3.231+05	9.293+04
13	4.680+09	3.464-01	6.505+10	6.419+02	9.982-01	2.887+00	4.680+09	4.680+09	3.297+05	9.673+04
14	5.040+09	3.437-01	6.877+10	6.650+02	9.982-01	2.910+00	5.040+09	5.040+09	3.358+05	1.004+05
15	5.400+09	3.413-01	7.219+10	6.896+02	9.982-01	2.930+00	5.400+09	5.400+09	3.413+05	1.037+05
16	5.760+09	3.387-01	7.600+10	7.112+02	9.982-01	2.953+00	5.760+09	5.760+09	3.472+05	1.073+05
17	6.120+09	3.365-01	7.931+10	7.356+02	9.982-01	2.972+00	6.120+09	6.120+09	3.521+05	1.104+05
18	6.480+09	3.343-01	8.276+10	7.588+02	9.982-01	2.991+00	6.480+09	6.480+09	3.572+05	1.136+05
19	6.840+09	3.322-01	8.618+10	7.818+02	9.982-01	3.011+00	6.840+09	6.840+09	3.620+05	1.167+05
20	7.200+09	3.301-01	8.957+10	8.048+02	9.982-01	3.029+00	7.200+09	7.200+09	3.667+05	1.197+05
21	7.560+09	3.281-01	9.291+10	8.278+02	9.982-01	3.048+00	7.560+09	7.560+09	3.711+05	1.227+05
22	7.920+09	3.262-01	9.622+10	8.508+02	9.982-01	3.066+00	7.920+09	7.920+09	3.755+05	1.256+05
23	8.280+09	3.244-01	9.949+10	8.738+02	9.982-01	3.083+00	8.280+09	8.280+09	3.797+05	1.285+05
24	8.640+09	3.226-01	1.027+11	8.968+02	9.982-01	3.100+00	8.640+09	8.640+09	3.837+05	1.312+05
25	9.000+09	3.208-01	1.059+11	9.199+02	9.982-01	3.117+00	9.000+09	9.000+09	3.877+05	1.339+05
26	9.360+09	3.192-01	1.091+11	9.430+02	9.982-01	3.133+00	9.360+09	9.360+09	3.915+05	1.366+05
27	9.720+09	3.175-01	1.122+11	9.661+02	9.982-01	3.149+00	9.720+09	9.720+09	3.952+05	1.392+05
28	1.008+10	3.160-01	1.154+11	9.893+02	9.982-01	3.165+00	1.008+10	1.008+10	3.989+05	1.418+05
29	1.044+10	3.144-01	1.185+11	1.012+03	9.982-01	3.180+00	1.044+10	1.044+10	4.024+05	1.443+05
30	1.080+10	3.129-01	1.215+11	1.036+03	9.982-01	3.195+00	1.080+10	1.080+10	4.059+05	1.468+05
31	1.116+10	3.115-01	1.246+11	1.059+03	9.982-01	3.210+00	1.116+10	1.116+10	4.093+05	1.492+05
32	1.152+10	3.101-01	1.276+11	1.082+03	9.982-01	3.225+00	1.152+10	1.152+10	4.126+05	1.516+05
33	1.188+10	3.087-01	1.306+11	1.106+03	9.982-01	3.239+00	1.188+10	1.188+10	4.158+05	1.539+05
34	1.224+10	3.074-01	1.336+11	1.129+03	9.982-01	3.253+00	1.224+10	1.224+10	4.190+05	1.563+05
35	1.260+10	3.061-01	1.365+11	1.153+03	9.982-01	3.267+00	1.260+10	1.260+10	4.221+05	1.586+05
36	1.296+10	3.048-01	1.395+11	1.176+03	9.982-01	3.281+00	1.296+10	1.296+10	4.251+05	1.608+05
37	1.332+10	3.035-01	1.424+11	1.200+03	9.982-01	3.295+00	1.332+10	1.332+10	4.281+05	1.630+05
38	1.368+10	3.023-01	1.453+11	1.223+03	9.982-01	3.308+00	1.368+10	1.368+10	4.311+05	1.652+05
39	1.404+10	3.011-01	1.482+11	1.247+03	9.982-01	3.321+00	1.404+10	1.404+10	4.340+05	1.674+05
40	1.440+10	2.999-01	1.511+11	1.271+03	9.982-01	3.334+00	1.440+10	1.440+10	4.368+05	1.695+05
41	1.476+10	2.988-01	1.539+11	1.294+03	9.982-01	3.347+00	1.476+10	1.476+10	4.396+05	1.716+05
42	1.512+10	2.977-01	1.568+11	1.318+03	9.982-01	3.359+00	1.512+10	1.512+10	4.423+05	1.737+05
43	1.548+10	2.966-01	1.596+11	1.342+03	9.982-01	3.372+00	1.548+10	1.548+10	4.451+05	1.758+05
44	1.584+10	2.955-01	1.624+11	1.366+03	9.982-01	3.384+00	1.584+10	1.584+10	4.477+05	1.778+05
45	1.620+10	2.944-01	1.652+11	1.390+03	9.982-01	3.396+00	1.620+10	1.620+10	4.503+05	1.798+05
46	1.656+10	2.934-01	1.680+11	1.414+03	9.982-01	3.408+00	1.656+10	1.656+10	4.529+05	1.818+05
47	1.692+10	2.924-01	1.708+11	1.438+03	9.982-01	3.420+00	1.692+10	1.692+10	4.555+05	1.838+05
48	1.728+10	2.914-01	1.735+11	1.462+03	9.982-01	3.432+00	1.728+10	1.728+10	4.580+05	1.857+05
49	1.764+10	2.904-01	1.763+11	1.486+03	9.982-01	3.443+00	1.764+10	1.764+10	4.605+05	1.877+05

TABLE B.5 (Continued)

.00 Percent Water, 15 Percent Porosity Mixture (Continued)

50	1.800+10	2.89[illegible]-01	1.790+11	1.511+03	9.982-01	3.455+00	1.800+10	1.800+10	4.629+05	1.896+05
51	1.836+10	2.88[illegible]-01	1.818+11	1.535+03	9.982-01	3.466+00	1.836+10	1.836+10	4.654+05	1.915+05
52	1.872+10	2.87[illegible]-01	1.845+11	1.559+03	9.982-01	3.477+00	1.872+10	1.872+10	4.678+05	1.933+05
53	1.908+10	2.867-01	1.872+11	1.584+03	9.982-01	3.488+00	1.908+10	1.908+10	4.701+05	1.952+05
54	1.944+10	2.858-01	1.899+11	1.608+03	9.982-01	3.499+00	1.944+10	1.944+10	4.725+05	1.970+05
55	1.980+10	2.849-01	1.926+11	1.632+03	9.982-01	3.510+00	1.980+10	1.980+10	4.748+05	1.989+05
56	2.016+10	2.840-01	1.953+11	1.657+03	9.982-01	3.521+00	2.016+10	2.016+10	4.771+05	2.007+05
57	2.052+10	2.832-01	1.979+11	1.682+03	9.982-01	3.532+00	2.052+10	2.052+10	4.793+05	2.024+05
58	2.088+10	2.823-01	2.006+11	1.706+03	9.982-01	3.542+00	2.088+10	2.088+10	4.815+05	2.042+05
59	2.124+10	2.815-01	2.033+11	1.731+03	9.982-01	3.553+00	2.124+10	2.124+10	4.838+05	2.060+05
60	2.160+10	2.807-01	2.059+11	1.756+03	9.982-01	3.563+00	2.160+10	2.160+10	4.859+05	2.077+05
61	2.196+10	2.799-01	2.085+11	1.780+03	9.982-01	3.573+00	2.196+10	2.196+10	4.881+05	2.094+05
62	2.232+10	2.791-01	2.112+11	1.805+03	9.982-01	3.583+00	2.232+10	2.232+10	4.903+05	2.111+05
63	2.268+10	2.783-01	2.138+11	1.830+03	9.982-01	3.593+00	2.268+10	2.268+10	4.924+05	2.128+05
64	2.304+10	2.775-01	2.164+11	1.855+03	9.982-01	3.603+00	2.304+10	2.304+10	4.945+05	2.145+05
65	2.340+10	2.768-01	2.190+11	1.880+03	9.982-01	3.613+00	2.340+10	2.340+10	4.966+05	2.162+05
66	2.376+10	2.760-01	2.216+11	[illegible]	9.982-01	3.623+00	2.376+10	2.376+10	4.986+05	2.179+05
67	2.412+10	2.753-01	2.242+11	1.930+03	9.982-01	3.633+00	2.412+10	2.412+10	5.007+05	2.195+05
68	2.448+10	2.746-01	2.268+11	1.955+03	9.982-01	3.642+00	2.448+10	2.448+10	5.027+05	2.211+05
69	2.484+10	2.738-01	2.293+11	1.980+03	9.982-01	3.652+00	2.484+10	2.484+10	5.047+05	2.228+05
70	2.520+10	2.731-01	2.319+11	2.005+03	9.982-01	3.661+00	2.520+10	2.520+10	5.067+05	2.244+05
71	2.556+10	2.724-01	2.345+11	2.030+03	9.982-01	3.671+00	2.556+10	2.556+10	5.086+05	2.260+05
72	2.592+10	2.717-01	2.370+11	2.056+03	9.982-01	3.680+00	2.592+10	2.592+10	5.106+05	2.276+05
73	2.628+10	2.711-01	2.396+11	2.081+03	9.982-01	3.689+00	2.628+10	2.628+10	5.125+05	2.291+05
74	2.664+10	2.704-01	2.421+11	2.106+03	9.982-01	3.699+00	2.664+10	2.664+10	5.145+05	2.307+05
75	2.700+10	2.697-01	2.447+11	2.132+03	9.982-01	3.708+00	2.700+10	2.700+10	5.164+05	2.323+05
76	2.736+10	2.691-01	2.472+11	2.157+03	9.982-01	3.717+00	2.736+10	2.736+10	5.183+05	2.338+05
77	2.772+10	2.684-01	2.497+11	2.183+03	9.982-01	3.726+00	2.772+10	2.772+10	5.201+05	2.353+05
78	2.808+10	2.678-01	2.522+11	2.208+03	9.982-01	3.735+00	2.808+10	2.808+10	5.220+05	2.369+05
79	2.844+10	2.671-01	2.547+11	2.234+03	9.982-01	3.743+00	2.844+10	2.844+10	5.238+05	2.384+05
80	2.880+10	2.665-01	2.572+11	2.259+03	9.982-01	3.752+00	2.880+10	2.880+10	5.257+05	2.399+05
81	2.916+10	2.659-01	2.597+11	2.285+03	9.982-01	3.761+00	2.916+10	2.916+10	5.275+05	2.414+05
82	2.952+10	2.653-01	2.622+11	2.311+03	9.982-01	3.770+00	2.952+10	2.952+10	5.293+05	2.429+05
83	2.988+10	2.647-01	2.647+11	2.336+03	9.982-01	3.778+00	2.988+10	2.988+10	5.311+05	2.443+05
84	3.024+10	2.641-01	2.672+11	2.362+03	9.982-01	3.787+00	3.024+10	3.024+10	5.329+05	2.458+05
85	3.060+10	2.635-01	2.697+11	2.388+03	9.982-01	3.795+00	3.060+10	3.060+10	5.346+05	2.473+05
86	3.096+10	2.629-01	2.722+11	2.414+03	9.982-01	3.804+00	3.096+10	3.096+10	5.364+05	2.487+05
87	3.132+10	2.623-01	2.746+11	2.440+03	9.982-01	3.812+00	3.132+10	3.132+10	5.381+05	2.502+05
88	3.168+10	2.618-01	2.771+11	2.466+03	9.982-01	3.820+00	3.168+10	3.168+10	5.399+05	2.516+05
89	3.204+10	2.612-01	2.796+11	2.492+03	9.982-01	3.829+00	3.204+10	3.204+10	5.416+05	2.530+05
90	3.240+10	2.606-01	2.820+11	2.518+03	9.982-01	3.837+00	3.240+10	3.240+10	5.433+05	2.544+05
91	3.276+10	2.601-01	2.845+11	2.544+03	9.982-01	3.845+00	3.276+10	3.276+10	5.450+05	2.559+05
92	3.312+10	2.595-01	2.869+11	2.570+03	9.982-01	3.853+00	3.312+10	3.312+10	5.467+05	2.573+05
93	3.348+10	2.590-01	2.894+11	2.596+03	9.982-01	3.861+00	3.348+10	3.348+10	5.484+05	2.587+05
94	3.384+10	2.584-01	2.918+11	2.623+03	9.982-01	3.869+00	3.384+10	3.384+10	5.500+05	2.600+05
95	3.420+10	2.579-01	2.942+11	2.649+03	9.982-01	3.877+00	3.420+10	3.420+10	5.517+05	2.614+05
96	3.456+10	2.574-01	2.967+11	2.675+03	9.982-01	3.885+00	3.456+10	3.456+10	5.533+05	2.628+05
97	3.492+10	2.569-01	2.991+11	2.701+03	9.982-01	3.893+00	3.492+10	3.492+10	5.550+05	2.642+05
98	3.528+10	2.564-01	3.015+11	2.728+03	9.982-01	3.901+00	3.528+10	3.528+10	5.566+05	2.655+05

TABLE B.5 (Continued)

.00 PERCENT WATER, 10 PERCENT POROSITY MIXTURE

K	AIR	TVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	3.995-01	1.134+10	3.290+02	9.982-01	2.503+00	3.600+08	3.600+08	1.957+05	2.683+04
2	7.200+08	3.889-01	1.945+10	3.557+02	9.982-01	2.571+00	7.200+08	7.200+08	2.373+05	3.794+04
3	1.080+09	3.809-01	2.630+10	3.793+02	9.982-01	2.625+00	1.080+09	1.080+09	2.621+05	4.646+04
4	1.440+09	3.743-01	3.244+10	4.013+02	9.982-01	2.672+00	1.440+09	1.440+09	2.800+05	5.364+04
5	1.800+09	3.686-01	3.810+10	4.223+02	9.982-01	2.713+00	1.800+09	1.800+09	2.941+05	5.997+04
6	2.160+09	3.635-01	4.342+10	4.428+02	9.982-01	2.751+00	2.160+09	2.160+09	3.059+05	6.570+04
7	2.520+09	3.590-01	4.846+10	4.629+02	9.982-01	2.785+00	2.520+09	2.520+09	3.161+05	7.097+04
8	2.880+09	3.549-01	5.328+10	4.828+02	9.982-01	2.817+00	2.880+09	2.880+09	3.251+05	7.587+04
9	3.240+09	3.512-01	5.793+10	5.025+02	9.982-01	2.848+00	3.240+09	3.240+09	3.333+05	8.047+04
10	3.600+09	3.477-01	6.242+10	5.221+02	9.982-01	2.876+00	3.600+09	3.600+09	3.407+05	8.483+04
11	3.960+09	3.444-01	6.678+10	5.417+02	9.982-01	2.903+00	3.960+09	3.960+09	3.475+05	8.897+04
12	4.320+09	3.414-01	7.103+10	5.612+02	9.982-01	2.929+00	4.320+09	4.320+09	3.539+05	9.293+04
13	4.680+09	3.385-01	7.518+10	5.808+02	9.982-01	2.954+00	4.680+09	4.680+09	3.598+05	9.673+04
14	5.040+09	3.358-01	7.924+10	6.003+02	9.982-01	2.978+00	5.040+09	5.040+09	3.655+05	1.004+05
15	5.400+09	3.332-01	8.322+10	6.199+02	9.982-01	3.001+00	5.400+09	5.400+09	3.708+05	1.039+05
16	5.760+09	3.310-01	8.686+10	6.412+02	9.982-01	3.021+00	5.760+09	5.760+09	3.756+05	1.071+05
17	6.120+09	3.285-01	9.096+10	6.592+02	9.982-01	3.045+00	6.120+09	6.120+09	3.807+05	1.106+05
18	6.480+09	3.264-01	9.449+10	6.807+02	9.982-01	3.064+00	6.480+09	6.480+09	3.851+05	1.136+05
19	6.840+09	3.243-01	9.818+10	7.007+02	9.982-01	3.084+00	6.840+09	6.840+09	3.895+05	1.167+05
20	7.200+09	3.222-01	1.018+11	7.206+02	9.982-01	3.104+00	7.200+09	7.200+09	3.938+05	1.197+05
21	7.560+09	3.202-01	1.055+11	7.406+02	9.982-01	3.123+00	7.560+09	7.560+09	3.980+05	1.227+05
22	7.920+09	3.183-01	1.091+11	7.606+02	9.982-01	3.142+00	7.920+09	7.920+09	4.020+05	1.256+05
23	8.280+09	3.165-01	1.126+11	7.807+02	9.982-01	3.160+00	8.280+09	8.280+09	4.059+05	1.284+05
24	8.640+09	3.147-01	1.161+11	8.008+02	9.982-01	3.178+00	8.640+09	8.640+09	4.097+05	1.312+05
25	9.000+09	3.130-01	1.196+11	8.211+02	9.982-01	3.195+00	9.000+09	9.000+09	4.134+05	1.339+05
26	9.360+09	3.113-01	1.230+11	8.414+02	9.982-01	3.212+00	9.360+09	9.360+09	4.170+05	1.366+05
27	9.720+09	3.097-01	1.264+11	8.618+02	9.982-01	3.229+00	9.720+09	9.720+09	4.204+05	1.392+05
28	1.008+10	3.081-01	1.298+11	8.822+02	9.982-01	3.245+00	1.008+10	1.008+10	4.239+05	1.418+05
29	1.044+10	3.066-01	1.331+11	9.028+02	9.982-01	3.262+00	1.044+10	1.044+10	4.272+05	1.443+05
30	1.080+10	3.051-01	1.364+11	9.234+02	9.982-01	3.277+00	1.080+10	1.080+10	4.304+05	1.468+05
31	1.116+10	3.037-01	1.397+11	9.441+02	9.982-01	3.293+00	1.116+10	1.116+10	4.336+05	1.492+05
32	1.152+10	3.023-01	1.430+11	9.649+02	9.982-01	3.308+00	1.152+10	1.152+10	4.367+05	1.516+05
33	1.188+10	3.009-01	1.462+11	9.858+02	9.982-01	3.323+00	1.188+10	1.188+10	4.398+05	1.539+05
34	1.224+10	2.996-01	1.494+11	1.007+03	9.982-01	3.338+00	1.224+10	1.224+10	4.428+05	1.563+05
35	1.260+10	2.983-01	1.526+11	1.028+03	9.982-01	3.352+00	1.260+10	1.260+10	4.457+05	1.585+05
36	1.296+10	2.970-01	1.558+11	1.049+03	9.982-01	3.367+00	1.296+10	1.296+10	4.486+05	1.608+05
37	1.332+10	2.958-01	1.590+11	1.070+03	9.982-01	3.381+00	1.332+10	1.332+10	4.515+05	1.630+05
38	1.368+10	2.946-01	1.621+11	1.091+03	9.982-01	3.395+00	1.368+10	1.368+10	4.542+05	1.652+05
39	1.404+10	2.934-01	1.652+11	1.113+03	9.982-01	3.408+00	1.404+10	1.404+10	4.570+05	1.674+05
40	1.440+10	2.922-01	1.683+11	1.134+03	9.982-01	3.422+00	1.440+10	1.440+10	4.597+05	1.695+05
41	1.476+10	2.911-01	1.714+11	1.156+03	9.982-01	3.435+00	1.476+10	1.476+10	4.623+05	1.716+05
42	1.512+10	2.900-01	1.745+11	1.177+03	9.982-01	3.448+00	1.512+10	1.512+10	4.650+05	1.737+05
43	1.548+10	2.889-01	1.775+11	1.199+03	9.982-01	3.461+00	1.548+10	1.548+10	4.675+05	1.758+05
44	1.584+10	2.878-01	1.805+11	1.220+03	9.982-01	3.474+00	1.584+10	1.584+10	4.701+05	1.778+05
45	1.620+10	2.868-01	1.836+11	1.242+03	9.982-01	3.487+00	1.620+10	1.620+10	4.726+05	1.798+05
46	1.656+10	2.858-01	1.866+11	1.264+03	9.982-01	3.499+00	1.656+10	1.656+10	4.751+05	1.818+05
47	1.692+10	2.848-01	1.896+11	1.286+03	9.982-01	3.512+00	1.692+10	1.692+10	4.775+05	1.838+05
48	1.728+10	2.838-01	1.925+11	1.308+03	9.982-01	3.524+00	1.728+10	1.728+10	4.799+05	1.857+05
49	1.764+10	2.828-01	1.955+11	1.330+03	9.982-01	3.536+00	1.764+10	1.764+10	4.823+05	1.877+05

TABLE B.5 (Continued)

.00 Percent Water, 10 Percent Porosity Mixture (Continued)

50	1.800+10	2.819-01	1.984+11	1.352+03	9.982-01	3.548+00	1.800+10	1.800+10	4.846+05	1.896+05
51	1.836+10	2.809-01	2.014+11	1.374+03	9.982-01	3.560+00	1.836+10	1.836+10	4.870+05	1.915+05
52	1.872+10	2.800-01	2.043+11	1.397+03	9.982-01	3.571+00	1.872+10	1.872+10	4.893+05	1.933+05
53	1.908+10	2.791-01	2.072+11	1.419+03	9.982-01	3.583+00	1.908+10	1.908+10	4.915+05	1.952+05
54	1.944+10	2.782-01	2.101+11	1.441+03	9.982-01	3.594+00	1.944+10	1.944+10	4.938+05	1.970+05
55	1.980+10	2.774-01	2.130+11	1.464+03	9.982-01	3.605+00	1.980+10	1.980+10	4.960+05	1.988+05
56	2.016+10	2.765-01	2.159+11	1.486+03	9.982-01	3.617+00	2.016+10	2.016+10	4.982+05	2.006+05
57	2.052+10	2.757-01	2.188+11	1.509+03	9.982-01	3.628+00	2.052+10	2.052+10	5.003+05	2.024+05
58	2.088+10	2.748-01	2.216+11	1.532+03	9.982-01	3.639+00	2.088+10	2.088+10	5.025+05	2.042+05
59	2.124+10	2.740-01	2.245+11	1.554+03	9.982-01	3.650+00	2.124+10	2.124+10	5.046+05	2.060+05
60	2.160+10	2.732-01	2.273+11	1.577+03	9.982-01	3.660+00	2.160+10	2.160+10	5.047+05	2.077+05
61	2.196+10	2.724-01	2.302+11	1.600+03	9.982-01	3.671+00	2.196+10	2.196+10	5.088+05	2.094+05
62	2.232+10	2.716-01	2.330+11	1.623+03	9.982-01	3.682+00	2.232+10	2.232+10	5.109+05	2.111+05
63	2.268+10	2.709-01	2.358+11	1.646+03	9.982-01	3.692+00	2.268+10	2.268+10	5.129+05	2.128+05
64	2.304+10	2.701-01	2.386+11	1.669+03	9.982-01	3.702+00	2.304+10	2.304+10	5.149+05	2.145+05
65	2.340+10	2.693-01	2.414+11	1.692+03	9.982-01	3.713+00	2.340+10	2.340+10	5.169+05	2.162+05
66	2.376+10	2.686-01	2.442+11	1.715+03	9.982-01	3.723+00	2.376+10	2.376+10	5.189+05	2.179+05
67	2.412+10	2.679-01	2.470+11	1.738+03	9.982-01	3.733+00	2.412+10	2.412+10	5.209+05	2.195+05
68	2.448+10	2.672-01	2.497+11	1.762+03	9.982-01	3.743+00	2.448+10	2.448+10	5.229+05	2.211+05
69	2.484+10	2.665-01	2.525+11	1.785+03	9.982-01	3.753+00	2.484+10	2.484+10	5.248+05	2.228+05
70	2.520+10	2.658-01	2.553+11	1.808+03	9.982-01	3.763+00	2.520+10	2.520+10	5.267+05	2.244+05
71	2.556+10	2.651-01	2.580+11	1.832+03	9.982-01	3.773+00	2.556+10	2.556+10	5.286+05	2.260+05
72	2.592+10	2.644-01	2.608+11	1.855+03	9.982-01	3.782+00	2.592+10	2.592+10	5.305+05	2.276+05
73	2.628+10	2.637-01	2.635+11	1.879+03	9.982-01	3.792+00	2.628+10	2.628+10	5.324+05	2.291+05
74	2.664+10	2.631-01	2.662+11	1.902+03	9.982-01	3.802+00	2.664+10	2.664+10	5.343+05	2.307+05
75	2.700+10	2.624-01	2.689+11	1.926+03	9.982-01	3.811+00	2.700+10	2.700+10	5.361+05	2.322+05
76	2.736+10	2.618-01	2.717+11	1.950+03	9.982-01	3.820+00	2.736+10	2.736+10	5.379+05	2.338+05
77	2.772+10	2.611-01	2.744+11	1.974+03	9.982-01	3.830+00	2.772+10	2.772+10	5.397+05	2.353+05
78	2.808+10	2.605-01	2.771+11	1.998+03	9.982-01	3.839+00	2.808+10	2.808+10	5.416+05	2.369+05
79	2.844+10	2.599-01	2.798+11	2.021+03	9.982-01	3.848+00	2.844+10	2.844+10	5.433+05	2.384+05
80	2.880+10	2.592-01	2.824+11	2.045+03	9.982-01	3.857+00	2.880+10	2.880+10	5.451+05	2.399+05
81	2.916+10	2.586-01	2.851+11	2.069+03	9.982-01	3.866+00	2.916+10	2.916+10	5.469+05	2.414+05
82	2.952+10	2.580-01	2.878+11	2.094+03	9.982-01	3.875+00	2.952+10	2.952+10	5.486+05	2.429+05
83	2.988+10	2.574-01	2.905+11	2.118+03	9.982-01	3.884+00	2.988+10	2.988+10	5.504+05	2.443+05
84	3.024+10	2.568-01	2.931+11	2.142+03	9.982-01	3.893+00	3.024+10	3.024+10	5.521+05	2.458+05
85	3.060+10	2.563-01	2.958+11	2.166+03	9.982-01	3.902+00	3.060+10	3.060+10	5.538+05	2.473+05
86	3.096+10	2.557-01	2.984+11	2.190+03	9.982-01	3.911+00	3.096+10	3.096+10	5.555+05	2.487+05
87	3.132+10	2.551-01	3.011+11	2.215+03	9.982-01	3.920+00	3.132+10	3.132+10	5.572+05	2.502+05

TABLE B.5 (Continued)

.00 PERCENT WATER, 5 PERCENT POROSITY MIXTURE

K	AIX	TVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	3.932-01	1.587+10	3.205+02	9.982-01	2.543+00	3.600+08	3.600+08	2.594+05	2.683+04
2	7.200+08	3.817-01	2.527+10	3.386+02	9.982-01	2.620+00	7.200+08	7.200+08	[illegible]	3.790+04
3	1.080+09	3.733-01	3.304+10	3.547+02	9.982-01	2.679+00	1.080+09	1.080+09	3.119+05	4.646+04
4	1.440+09	3.664-01	3.987+10	3.701+02	9.982-01	2.729+00	1.440+09	1.440+09	3.260+05	5.364+04
5	1.800+09	3.606-01	4.612+10	3.853+02	9.982-01	2.773+00	1.800+09	1.800+09	3.373+05	5.997+04
6	2.160+09	3.555-01	5.196+10	4.003+02	9.982-01	2.813+00	2.160+09	2.160+09	3.469+05	[illegible]
7	2.520+09	3.510-01	5.748+10	4.153+02	9.982-01	2.849+00	2.520+09	2.520+09	3.552+05	7.096+04
8	2.880+09	3.469-01	6.274+10	4.303+02	9.982-01	2.883+00	2.880+09	2.880+09	3.627+05	7.587+04
9	3.240+09	3.431-01	6.780+10	4.455+02	9.982-01	2.915+00	3.240+09	3.240+09	3.695+05	8.047+04
10	3.600+09	3.396-01	7.268+10	4.608+02	9.982-01	2.945+00	3.600+09	3.600+09	3.758+05	8.483+04
11	3.960+09	3.364-01	7.742+10	4.762+02	9.982-01	2.973+00	3.960+09	3.960+09	3.817+05	8.897+04
12	4.320+09	3.333-01	8.202+10	4.917+02	9.982-01	3.000+00	4.320+09	4.320+09	3.871+05	9.293+04
13	4.680+09	3.305-01	8.652+10	5.074+02	9.982-01	3.026+00	4.680+09	4.680+09	3.923+05	9.672+04
14	5.040+09	3.278-01	9.091+10	5.232+02	9.982-01	3.051+00	5.040+09	5.040+09	3.972+05	1.004+05
15	5.400+09	3.252-01	9.521+10	5.391+02	9.982-01	3.075+00	5.400+09	5.400+09	4.019+05	1.039+05
16	5.760+09	3.230-01	9.914+10	5.573+02	9.982-01	3.096+00	5.760+09	5.760+09	4.061+05	1.071+05
17	6.120+09	3.205-01	1.036+11	5.716+02	9.982-01	3.120+00	6.120+09	6.120+09	4.107+05	1.106+05
18	6.480+09	3.184-01	1.074+11	5.900+02	9.982-01	3.140+00	6.480+09	6.480+09	4.146+05	1.136+05
19	6.840+09	3.163-01	1.113+11	6.069+02	9.982-01	3.161+00	6.840+09	6.840+09	4.186+05	1.167+05
20	7.200+09	3.143-01	1.153+11	6.236+02	9.982-01	3.182+00	7.200+09	7.200+09	4.224+05	1.197+05
21	7.560+09	3.123-01	1.192+11	6.405+02	9.982-01	3.202+00	7.560+09	7.560+09	4.262+05	1.227+05
22	7.920+09	3.104-01	1.231+11	6.574+02	9.982-01	3.221+00	7.920+09	7.920+09	4.298+05	1.256+05
23	8.280+09	3.086-01	1.269+11	6.745+02	9.982-01	3.240+00	8.280+09	8.280+09	4.334+05	1.284+05
24	8.640+09	3.069-01	1.307+11	6.918+02	9.982-01	3.259+00	8.640+09	8.640+09	4.368+05	1.312+05
25	9.000+09	3.052-01	1.344+11	7.092+02	9.982-01	3.277+00	9.000+09	9.000+09	4.402+05	1.339+05
26	9.360+09	3.035-01	1.381+11	7.267+02	9.982-01	3.295+00	9.360+09	9.360+09	4.435+05	1.366+05
27	9.720+09	3.019-01	1.418+11	7.443+02	9.982-01	3.312+00	9.720+09	9.720+09	4.467+05	1.392+05
28	1.008+10	3.004-01	1.454+11	7.620+02	9.982-01	3.329+00	1.008+10	1.008+10	4.498+05	1.417+05
29	1.044+10	2.989-01	1.490+11	7.799+02	9.982-01	3.346+00	1.044+10	1.044+10	4.529+05	1.443+05
30	1.080+10	2.974-01	1.525+11	7.979+02	9.982-01	3.362+00	1.080+10	1.080+10	4.559+05	1.467+05
31	1.116+10	2.960-01	1.561+11	8.160+02	9.982-01	3.378+00	1.116+10	1.116+10	4.588+05	1.492+05
32	1.152+10	2.946-01	1.596+11	8.343+02	9.982-01	3.394+00	1.152+10	1.152+10	4.617+05	1.516+05
33	1.188+10	2.933-01	1.630+11	8.526+02	9.982-01	3.410+00	1.188+10	1.188+10	4.646+05	1.539+05
34	1.224+10	2.920-01	1.665+11	8.711+02	9.982-01	3.425+00	1.224+10	1.224+10	4.674+05	1.562+05
35	1.260+10	2.907-01	1.699+11	8.897+02	9.982-01	3.440+00	1.260+10	1.260+10	4.701+05	1.585+05
36	1.296+10	2.894-01	1.733+11	9.083+02	9.982-01	3.455+00	1.296+10	1.296+10	4.728+05	1.608+05
37	1.332+10	2.882-01	1.767+11	9.271+02	9.982-01	3.470+00	1.332+10	1.332+10	4.755+05	1.630+05
38	1.368+10	2.870-01	1.801+11	9.460+02	9.982-01	3.484+00	1.368+10	1.368+10	4.781+05	1.652+05
39	1.404+10	2.859-01	1.834+11	9.650+02	9.982-01	3.498+00	1.404+10	1.404+10	4.807+05	1.674+05
40	1.440+10	2.847-01	1.867+11	9.841+02	9.982-01	3.512+00	1.440+10	1.440+10	4.832+05	1.695+05
41	1.476+10	2.836-01	1.900+11	1.003+03	9.982-01	3.526+00	1.476+10	1.476+10	4.857+05	1.716+05
42	1.512+10	2.825-01	1.933+11	1.023+03	9.982-01	3.540+00	1.512+10	1.512+10	4.882+05	1.737+05
43	1.548+10	2.815-01	1.966+11	1.042+03	9.982-01	3.553+00	1.548+10	1.548+10	4.906+05	1.758+05
44	1.584+10	2.804-01	1.999+11	1.062+03	9.982-01	3.566+00	1.584+10	1.584+10	4.930+05	1.778+05
45	1.620+10	2.794-01	2.031+11	1.081+03	9.982-01	3.579+00	1.620+10	1.620+10	4.954+05	1.798+05
46	1.656+10	2.784-01	2.063+11	1.101+03	9.982-01	3.592+00	1.656+10	1.656+10	4.977+05	1.818+05
47	1.692+10	2.774-01	2.095+11	1.121+03	9.982-01	3.605+00	1.692+10	1.692+10	5.000+05	1.838+05
48	1.728+10	2.764-01	2.127+11	1.140+03	9.982-01	3.618+00	1.728+10	1.728+10	5.023+05	1.857+05
49	1.764+10	2.755-01	2.157+11	1.160+03	9.982-01	3.630+00	1.764+10	1.764+10	5.045+05	1.877+05

TABLE B.5 (Continued)

.00 Percent Water, 5 Percent Porosity Mixture (Continued)

50	1.800+10	2.745-01	2.190+11	1.180+03	9.982-01	3.643+00	1.800+10	1.800+10	5.068+05	1.896+05
51	1.836+10	2.736-01	2.222+11	1.201+03	9.982-01	3.655+00	1.836+10	1.836+10	5.090+05	1.915+05
52	1.872+10	2.727-01	2.253+11	1.221+03	9.982-01	3.667+00	1.872+10	1.872+10	5.112+05	1.933+05
53	1.908+10	2.718-01	2.284+11	1.241+03	9.982-01	3.679+00	1.908+10	1.908+10	5.133+05	1.952+05
54	1.944+10	2.710-01	2.315+11	1.262+03	9.982-01	3.691+00	1.944+10	1.944+10	5.155+05	1.970+05
55	1.980+10	2.701-01	2.346+11	1.282+03	9.982-01	3.702+00	1.980+10	1.980+10	5.176+05	1.988+05
56	2.016+10	2.693-01	2.377+11	1.303+03	9.982-01	3.714+00	2.016+10	2.016+10	5.197+05	2.006+05
57	2.052+10	2.684-01	2.408+11	1.323+03	9.982-01	3.725+00	2.052+10	2.052+10	5.217+05	2.024+05
58	2.088+10	2.676-01	2.437+11	1.344+03	9.982-01	3.737+00	2.088+10	2.088+10	5.238+05	2.042+05
59	2.124+10	2.668-01	2.469+11	1.365+03	9.982-01	3.748+00	2.124+10	2.124+10	5.258+05	2.059+05
60	2.160+10	2.660-01	2.499+11	1.386+03	9.982-01	3.759+00	2.160+10	2.160+10	5.278+05	2.077+05
61	2.196+10	2.652-01	2.530+11	1.407+03	9.982-01	3.770+00	2.196+10	2.196+10	5.298+05	2.094+05
62	2.232+10	2.645-01	2.560+11	1.428+03	9.982-01	3.781+00	2.232+10	2.232+10	5.318+05	2.111+05
63	2.268+10	2.637-01	2.590+11	1.449+03	9.982-01	3.792+00	2.268+10	2.268+10	5.338+05	2.128+05
64	2.304+10	2.630-01	2.620+11	1.470+03	9.982-01	3.803+00	2.304+10	2.304+10	5.357+05	2.145+05
65	2.340+10	2.622-01	2.650+11	1.491+03	9.982-01	3.813+00	2.340+10	2.340+10	5.376+05	2.162+05
66	2.376+10	2.615-01	2.680+11	1.513+03	9.982-01	3.824+00	2.376+10	2.376+10	5.395+05	2.178+05
67	2.412+10	2.608-01	2.709+11	1.534+03	9.982-01	3.834+00	2.412+10	2.412+10	5.414+05	2.195+05
68	2.448+10	2.601-01	2.739+11	1.555+03	9.982-01	3.845+00	2.448+10	2.448+10	5.433+05	2.211+05
69	2.484+10	2.594-01	2.769+11	1.577+03	9.982-01	3.855+00	2.484+10	2.484+10	5.452+05	2.227+05
70	2.520+10	2.587-01	2.798+11	1.599+03	9.982-01	3.865+00	2.520+10	2.520+10	5.470+05	2.244+05
71	2.556+10	2.580-01	2.828+11	1.620+03	9.982-01	3.876+00	2.556+10	2.556+10	5.488+05	2.260+05
72	2.592+10	2.574-01	2.857+11	1.642+03	9.982-01	3.886+00	2.592+10	2.592+10	5.507+05	2.275+05
73	2.628+10	2.567-01	2.886+11	1.664+03	9.982-01	3.896+00	2.628+10	2.628+10	5.525+05	2.291+05
74	2.664+10	2.560-01	2.915+11	1.686+03	9.982-01	3.906+00	2.664+10	2.664+10	5.543+05	2.307+05
75	2.700+10	2.554-01	2.944+11	1.708+03	9.982-01	3.915+00	2.700+10	2.700+10	5.560+05	2.322+05
76	2.736+10	2.548-01	2.973+11	1.730+03	9.982-01	3.925+00	2.736+10	2.736+10	5.578+05	2.338+05
77	2.772+10	2.541-01	3.002+11	1.752+03	9.982-01	3.935+00	2.772+10	2.772+10	5.596+05	2.353+05

TABLE B.5 (Continued)

5 PERCENT WATER, 20 PERCENT POROSITY MIXTURE

K	AIX	TVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	4.309-01	5.708+09	3.328+02	1.151+00	2.452+00	7.438+08	3.398+08	1.184+05	2.687+04
2	7.200+08	4.219-01	1.063+10	3.671+02	1.216+00	2.495+00	1.731+09	6.668+08	1.561+05	3.794+04
3	1.080+09	4.149-01	1.514+10	3.988+02	1.260+00	2.532+00	2.721+09	9.936+08	1.817+05	4.646+04
4	1.440+09	4.089-01	1.939+10	4.290+02	1.293+00	2.566+00	3.696+09	1.321+09	2.013+05	5.365+04
5	1.800+09	4.036-01	2.340+10	4.580+02	1.320+00	2.598+00	4.654+09	1.650+09	2.174+05	5.998+04
6	2.160+09	3.989-01	2.724+10	4.861+02	1.342+00	2.627+00	5.597+09	1.979+09	2.311+05	6.571+04
7	2.520+09	3.947-01	3.095+10	5.136+02	1.362+00	2.654+00	6.527+09	2.309+09	2.431+05	7.098+04
8	2.880+09	3.907-01	3.454+10	5.405+02	1.379+00	2.680+00	7.446+09	2.640+09	2.537+05	7.588+04
9	3.240+09	3.871-01	3.803+10	5.670+02	1.395+00	2.705+00	8.355+09	2.971+09	2.634+05	8.048+04
10	3.600+09	3.837-01	4.143+10	5.931+02	1.409+00	2.728+00	9.255+09	3.303+09	2.722+05	8.483+04
11	3.960+09	3.807-01	4.461+10	[illegible]	1.420+00	2.750+00	1.016+10	3.634+09	2.801+05	8.879+04
12	4.320+09	3.777-01	4.785+10	[illegible]	1.432+00	2.771+00	1.105+10	3.956+09	2.877+05	9.273+04
13	4.680+09	3.749-01	5.105+10	6.705+02	1.443+00	2.792+00	1.193+10	4.298+09	2.948+05	9.653+04
14	5.040+09	3.722-01	5.420+10	6.957+02	1.454+00	2.812+00	1.280+10	4.631+09	3.015+05	1.002+05
15	5.400+09	3.696-01	5.729+10	7.207+02	1.464+00	2.832+00	1.368+10	4.964+09	3.079+05	1.037+05
16	5.760+09	3.671-01	6.034+10	7.456+02	1.473+00	2.851+00	1.454+10	5.298+09	3.139+05	1.071+05
17	6.120+09	3.648-01	6.335+10	7.703+02	1.482+00	2.870+00	1.541+10	5.631+09	3.197+05	1.105+05
18	6.480+09	3.625-01	6.631+10	7.950+02	1.491+00	2.887+00	1.627+10	5.965+09	3.252+05	1.137+05
19	6.840+09	3.604-01	6.924+10	8.196+02	1.499+00	2.905+00	1.713+10	6.298+09	3.304+05	1.168+05
20	7.200+09	3.583-01	7.214+10	8.441+02	1.507+00	2.922+00	1.799+10	6.632+09	3.355+05	1.198+05
21	7.560+09	3.563-01	7.500+10	8.685+02	1.514+00	2.939+00	1.884+10	6.966+09	3.404+05	1.228+05
22	7.920+09	3.544-01	7.784+10	8.929+02	1.521+00	2.955+00	1.970+10	7.300+09	3.451+05	1.257+05
23	8.280+09	3.525-01	8.064+10	9.172+02	1.528+00	2.971+00	2.055+10	7.634+09	3.497+05	1.286+05
24	8.640+09	3.507-01	8.342+10	9.415+02	1.535+00	2.986+00	2.140+10	7.968+09	3.541+05	1.313+05
25	9.000+09	3.489-01	8.618+10	9.657+02	1.542+00	3.002+00	2.225+10	8.302+09	3.584+05	1.340+05
26	9.360+09	3.472-01	8.891+10	9.899+02	1.548+00	3.017+00	2.310+10	8.637+09	3.625+05	1.367+05
27	9.720+09	3.456-01	9.162+10	1.014+03	1.554+00	3.031+00	2.395+10	8.971+09	3.666+05	1.393+05
28	1.008+10	3.439-01	9.431+10	1.038+03	1.560+00	3.046+00	2.480+10	9.305+09	3.705+05	1.419+05
29	1.044+10	3.424-01	9.698+10	1.062+03	1.566+00	3.060+00	2.565+10	9.639+09	3.743+05	1.444+05
30	1.080+10	3.409-01	9.963+10	1.087+03	1.572+00	3.074+00	2.650+10	9.974+09	3.781+05	1.469+05
31	1.116+10	3.394-01	1.023+11	1.111+03	1.577+00	3.088+00	2.735+10	1.031+10	3.817+05	1.493+05
32	1.152+10	3.380-01	1.048+11	1.136+03	1.585+00	3.100+00	2.824+10	1.064+10	3.851+05	1.516+05
33	1.188+10	3.366-01	1.073+11	1.160+03	1.590+00	3.113+00	2.909+10	1.097+10	3.886+05	1.540+05
34	1.224+10	3.351-01	1.106+11	1.181+03	1.583+00	3.130+00	2.970+10	1.132+10	3.931+05	1.568+05
35	1.260+10	3.340-01	1.128+11	1.208+03	1.584+00	3.141+00	3.059+10	1.165+10	3.960+05	1.587+05
36	1.296+10	3.328-01	1.153+11	1.232+03	1.587+00	3.153+00	3.141+10	1.199+10	3.993+05	1.609+05
37	1.332+10	3.315-01	1.178+11	1.256+03	1.591+00	3.166+00	3.225+10	1.232+10	4.026+05	1.632+05
38	1.368+10	3.303-01	1.204+11	1.280+03	1.595+00	3.178+00	3.308+10	1.266+10	4.058+05	1.654+05
39	1.404+10	3.290-01	1.229+11	1.304+03	1.599+00	3.190+00	3.392+10	1.299+10	4.089+05	1.675+05
40	1.440+10	3.279-01	1.254+11	1.329+03	1.603+00	3.202+00	3.475+10	1.333+10	4.120+05	1.697+05
41	1.476+10	3.267-01	1.279+11	1.353+03	1.606+00	3.214+00	3.559+10	1.366+10	4.150+05	1.718+05
42	1.512+10	3.255-01	1.304+11	1.377+03	1.610+00	3.226+00	3.642+10	1.400+10	4.180+05	1.739+05
43	1.548+10	3.244-01	1.329+11	1.401+03	1.613+00	3.238+00	3.726+10	1.433+10	4.209+05	1.759+05
44	1.584+10	3.233-01	1.353+11	1.425+03	1.617+00	3.249+00	3.809+10	1.467+10	4.238+05	1.780+05
45	1.620+10	3.222-01	1.378+11	1.450+03	1.620+00	3.260+00	3.893+10	1.500+10	4.266+05	1.800+05
46	1.656+10	3.212-01	1.402+11	1.474+03	1.623+00	3.271+00	3.976+10	1.534+10	4.294+05	1.820+05
47	1.692+10	3.202-01	1.426+11	1.498+03	1.626+00	3.283+00	4.060+10	1.567+10	4.322+05	1.840+05
48	1.728+10	3.191-01	1.451+11	1.523+03	1.629+00	3.293+00	4.143+10	1.601+10	4.349+05	1.859+05
49	1.764+10	3.181-01	1.475+11	1.547+03	1.633+00	3.304+00	4.227+10	1.634+10	4.376+05	1.878+05

TABLE B.5 (Continued)

5 Percent Water, 20 Percent Porosity Mixture (Continued)

50	1.800+10	3.171-01	1.499+11	1.571+03	1.636+00	3.315+00	4.310+10	1.668+10	4.402+05	1.898+05
51	1.836+10	3.162-01	1.523+11	1.595+03	1.638+00	3.326+00	4.394+10	1.701+10	4.429+05	1.917+05
52	1.872+10	3.152-01	1.547+11	1.620+03	1.641+00	3.336+00	4.477+10	1.735+10	4.454+05	1.935+05
53	1.908+10	3.143-01	1.570+11	1.644+03	1.644+00	3.346+00	4.561+10	1.768+10	4.480+05	1.954+05
54	1.944+10	3.134-01	1.594+11	1.669+03	1.647+00	3.357+00	4.645+10	1.802+10	4.505+05	1.972+05
55	1.980+10	3.125-01	1.618+11	1.693+03	1.650+00	3.367+00	4.728+10	1.835+10	4.530+05	1.990+05
56	2.016+10	3.116-01	1.641+11	1.717+03	1.652+00	3.377+00	4.812+10	1.869+10	4.554+05	2.009+05
57	2.052+10	3.107-01	1.665+11	1 742+03	1.655+00	3.387+00	4.896+10	1.902+10	4.579+05	2.026+05
58	2.088+10	3.098-01	1.688+11	[illegible]	1.658+00	3.397+00	4.980+10	1.936+10	4.603+05	2.044+05
59	2.124+10	3.090-01	1.711+11	1.791+03	1.660+00	3.407+00	5.063+10	1.969+10	4.627+05	2.062+05
60	2.160+10	3.082-01	1.735+11	1.815+03	1.663+00	3.416+00	5.147+10	2.003+10	4.650+05	2.079+05
61	2.196+10	3.073-01	1.758+11	1.840+03	1.665+00	3.426+00	5.231+10	2.036+10	4.673+05	2.097+05
62	2.232+10	3.065-01	1.781+11	1.864+03	1.667+00	3.435+00	5.315+10	2.070+10	4.696+05	2.114+05
63	2.268+10	3.057-01	1.804+11	1.889+03	1.670+00	3.445+00	5.399+10	2.103+10	4.719+05	2.131+05
64	2.304+10	3.049-01	1.827+11	1.914+03	1.672+00	3.454+00	5.483+10	2.137+10	4.742+05	2.148+05
65	2.340+10	3.041-01	1.850+11	1.938+03	1.674+00	3.464+00	5.567+10	2.170+10	4.764+05	2.165+05
66	2.376+10	3.034-01	1.873+11	1.963+03	1.677+00	3.473+00	5.651+10	2.204+10	4.786+05	2.181+05
67	2.412+10	3.026-01	1.896+11	1.988+03	1.679+00	3.482+00	5.736+10	2.237+10	4.808+05	2.198+05
68	2.448+10	3.019-01	[illegible]	2.012+03	1.681+00	3.491+00	5.820+10	2.271+10	4.830+05	2.214+05
69	2.484+10	3.011-01	1.941+11	2.037+03	1.683+00	3.500+00	5.904+10	2.304+10	4.851+05	2.230+05
70	2.520+10	3.004-01	1.964+11	2.062+03	1.686+00	3.509+00	5.988+10	2.337+10	4.872+05	2.247+05
71	2.556+10	2.997-01	1.986+11	2.086+03	1.688+00	3.518+00	6.073+10	2.371+10	4.894+05	2.263+05
72	2.592+10	2.990-01	2.009+11	2.111+03	1.690+00	3.527 00	6.157+10	2.404+10	4.914+05	2.279+05
73	2.628+10	2.983-01	2.031+11	2.136+03	1.692+00	3.535+00	6.242+10	2.438+10	4.935+05	2.294+05
74	2.664+10	2.976-01	2.054+11	2.161+03	1.694+00	3.544+00	6.326+10	2.471+10	4.956+05	2.310+05
75	2.700+10	2.969-01	2.076+11	2.185+03	1.696+00	3.553+00	6.411+10	2.505+10	4.976+05	2.326+05
76	2.736+10	2.962-01	2.099+11	2.210+03	1.698+00	3.561+00	6.495+10	2.538+10	4.996+05	2.341+05
77	2.772+10	2.955-01	2.121+11	2.235+03	1.700+00	3.570+00	6.580+10	2.572+10	5.016+05	2.357+05
78	2.808+10	2.949-01	2.143+11	2.260+03	1.702+00	3.578+00	6.665+10	2.605+10	5.036+05	2.372+05
79	2.844+10	2.942-01	2.165+11	2.285+03	1.704+00	3.586+00	6.749+10	2.638+10	5.056+05	2.387+05
80	2.880+10	[illegible]	2.188+1	2.310+03	1.706+00	3.595+00	6.834+10	2.672+10	5.076+05	2.402+05
81	2.916+10	2.930-01	2.210+11	2.335+03	1.708+00	3.603+00	6.919+10	2.705+10	5.095+05	2.417+05
82	2.952+10	2.923-01	2.232+11	2.360+03	1.710+00	3.611+00	7.004+10	2.739+10	5.114+05	2.432+05
83	2.988+10	2.917-01	2.254+11	2.385+03	1.712+00	3.619+00	7.089+10	2.772+10	5.134+05	2.447+05
84	3.024+10	2.911-01	2.276+11	2.410+03	1.713+00	3.627+00	7.174+10	2.806+10	5.153+05	2.462+05
85	3.060+10	2.905-01	2.298+11	2.435+03	1.715+00	3.635+00	7.259+10	2.839+10	5.172+05	2.477+05
86	3.096+10	2.899-01	2.320+11	2.460+03	1.717+00	3.643+00	7.344+10	2.872+10	5.190+05	2.491+05
87	3.132+10	2.893-01	2.342+11	2.485+03	1.719+00	3.651+00	7.429+10	2.906+10	5.209+05	2.506+05
88	3.168+10	2.887-01	2.363+11	2.510+03	1.721+00	3.659+00	7.515+10	2.939+10	5.227+05	2.520+05
89	3.204+10	2.881-01	2.385+11	2.535+03	1.722+00	3.667+00	7.600+10	2.973+10	5.246+05	2.534+05
90	3.240+10	2.875-01	2.407+11	2.560+03	1.724+00	3.675+00	7.685+10	3.006+10	5.264+05	2.549+05
91	3.276+10	2.869-01	2.429+11	2.585+03	1.726+00	3.683+00	7.771+10	3.039+10	5.282+05	2.563+05
92	3.312+10	2.864-01	2.450+11	2.611+03	1.727+00	3.690+00	7.856+10	3.073+10	5.300+05	2.577+05
93	3.348+10	2.858-01	2.472+11	2.636+03	1.729+00	3.698+00	7.942+10	3.106+10	5.318+05	2.591+05
94	3.384+10	2.853-01	2.494+11	2.661+03	1.731+00	3.705+00	8.027+10	3.140+10	5.336+05	2.605+05
95	3.420+10	2.847-01	2.515+11	2.686+03	1.733+00	3.713+00	8.113+10	3.173+10	5.353+05	2.619+05
96	3.456+10	2.842-01	2.537+11	2.712+03	1.734+00	3.721+00	8.199+10	3.206+10	5.371+05	2.633+05
97	3.492+10	2.836-01	2.558+11	2.737+03	1.736+00	3.728+00	8.285+10	3.240+10	5.388+05	2.647+05
98	3.528+10	2.831-01	2.580+11	2.762+03	1.737+00	3.735+00	8.370+10	3.273+10	5.406+05	2.660+05
99	3.564+10	2.826-01	2.601+11	2.787+03	1.739+00	3.743+00	8.456+10	3.307+10	5.423+05	2.674+05
100	3.600+10	2.820-01	2.623+11	2.813+03	1.741+00	3.750+00	8.542+10	3.340+10	5.440+05	2.687+05
101	3.636+10	2.815-01	2.644+11	2.838+03	1.742+00	3.757+00	8.628+10	3.373+10	5.457+05	2.701+05
102	3.672+10	2.810-01	2.665+11	2.863+03	1.744+00	3.765+00	8.714+10	3.407+10	5.474+05	2.714+05
103	3.708+10	2.805-01	2.687+11	2.889+03	1.745+00	3.772+00	8.800+10	3.440+10	5.491+05	2.728+05

TABLE B.5 (Continued)

5 Percent Water, 20 Percent Porosity Mixture (Continued)

104	3.744+10	2.800-01	2.708+11	2.914+03	1.747+00	3.779+00	8.887+10	3.473+10	5.507+05	2.741+05
105	3.780+10	2.795-01	2.729+11	2.940+03	1.749+00	3.786+00	8.973+10	3.507+10	5.524+05	2.754+05
106	3.816+10	2.790-01	2.751+11	2.965+03	1.750+00	3.793+00	9.059+10	3.540+10	5.540+05	2.767+05
107	3.852+10	2.785-01	2.772+11	2.991+03	1.752+00	3.801+00	9.146+10	3.573+10	5.557+05	2.780+05
108	3.888+10	2.780-01	2.793+11	3.016+03	1.753+00	3.808+00	9.232+10	3.607+10	5.573+05	2.793+05
109	3.924+10	2.775-01	2.814+11	3.042+03	1.755+00	3.815+00	9.319+10	3.640+10	5.589+05	2.806+05
110	3.960+10	2.771-01	2.835+11	3.067+03	1.756+00	3.822+00	9.405+10	3.673+10	5.606+05	2.819+05
111	3.996+10	2.766-01	2.856+11	3.093+03	1.758+00	3.828+00	9.492+10	3.707+10	5.622+05	2.832+05
112	4.032+10	2.761-01	2.877+11	3.118+03	1.759+00	3.835+00	9.578+10	3.740+10	5.638+05	2.845+05
113	4.068+10	2.757-01	2.899+11	3.144+03	1.761+00	3.842+00	9.665+10	3.773+10	5.654+05	2.858+05
114	4.104+10	2.752-01	2.920+11	3.170+03	1.762+00	3.849+00	9.752+10	3.807+10	5.669+05	2.870+05
115	4.140+10	2.752-01	2.935+11	3.202+03	1.746+00	3.853+00	9.824+10	3.841+10	5.685+05	2.878+05
116	4.176+10	2.744-01	2.945+11	3.231+03	1.785+00	3.855+00	1.000+11	3.869+10	5.686+05	2.887+05
117	4.212+10	2.739-01	2.981+11	3.248+03	1.763+00	3.869+00	1.001+11	3.907+10	5.716+05	2.907+05
118	4.248+10	2.739-01	2.997+11	3.281+03	1.747+00	3.873+00	1.008+11	3.941+10	5.731+05	2.915+05
119	4.284+10	2.731-01	3.028+11	3.298+03	1.755+00	3.884+00	1.016+11	3.975+10	5.753+05	2.934+05

TABLE B.5 (Continued)

5 PERCENT WATER, 15 PERCENT POROSITY MIXTURE

K	AIX	TVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	4.272-01	7.412+09	3.321+02	1.186+00	2.468+00	6.425+08	3.451+08	1.447+05	2.688+04
2	7.200+08	4.170-01	1.338+10	3.636+02	1.256+00	2.519+00	1.575+09	6.750+08	1.849+05	3.795+04
3	1.080+09	4.091-01	1.869+10	3.923+02	1.303+00	2.563+00	2.500+09	1.005+09	2.110+05	4.646+04
4	1.440+09	4.025-01	2.358+10	4.192+02	1.339+00	2.601+00	3.409+09	1.336+09	2.306+05	5.365+04
5	1.800+09	3.969-01	2.816+10	4.450+02	1.369+00	2.636+00	4.302+09	1.668+09	2.463+05	5.998+04
6	2.160+09	3.919-01	3.252+10	4.699+02	1.394+00	2.669+00	5.182+09	2.001+09	2.596+05	6.571+04
7	2.520+09	3.873-01	3.669+10	4.942+02	1.416+00	2.699+00	6.051+09	2.334+09	2.712+05	7.097+04
8	2.880+09	3.832-01	4.070+10	5.180+02	1.435+00	2.727+00	6.911+09	2.668+09	2.815+05	7.587+04
9	3.240+09	3.794-01	4.459+10	5.414+02	1.453+00	2.754+00	7.765+09	3.002+09	2.907+05	8.047+04
10	3.600+09	3.759-01	4.837+10	5.646+02	1.469+00	2.779+00	8.612+09	3.336+09	2.991+05	8.483+04
11	3.960+09	3.726-01	5.205+10	5.875+02	1.484+00	2.803+00	9.454+09	3.671+09	3.069+05	8.897+04
12	4.320+09	3.696-01	5.549+10	6.110+02	1.496+00	2.826+00	1.020+10	4.005+09	3.139+05	9.274+04
13	4.680+09	3.667-01	5.900+10	6.337+02	1.508+00	2.848+00	1.113+10	4.340+09	3.207+05	9.652+04
14	5.040+09	3.639-01	6.246+10	6.561+02	1.521+00	2.870+00	1.196+10	4.676+09	3.271+05	1.002+05
15	5.400+09	3.613-01	6.586+10	6.785+02	1.532+00	2.891+00	1.279+10	5.011+09	3.331+05	1.037+05
16	5.760+09	3.588-01	6.921+10	7.007+02	1.543+00	2.911+00	1.361+10	5.347+09	3.389+05	1.071+05
17	6.120+09	3.564-01	7.250+10	7.229+02	1.553+00	2.930+00	1.443+10	5.682+09	3.444+05	1.104+05
18	6.480+09	3.541-01	7.575+10	7.450+02	1.563+00	2.949+00	1.526+10	6.018+09	3.496+05	1.137+05
19	6.840+09	3.519-01	7.895+10	7.671+02	1.573+00	2.968+00	1.608+10	6.354+09	3.547+05	1.168+05
20	7.200+09	3.497-01	8.212+10	7.891+02	1.582+00	2.986+00	1.689+10	6.690+09	3.595+05	1.198+05
21	7.560+09	3.477-01	8.524+10	8.111+02	1.591+00	3.004+00	1.771+10	7.026+09	3.642+05	1.228+05
22	7.920+09	3.457-01	8.834+10	8.331+02	1.599+00	3.021+00	1.853+10	7.362+09	3.687+05	1.257+05
23	8.280+09	3.438-01	9.140+10	8.551+02	1.607+00	3.038+00	1.935+10	7.697+09	3.730+05	1.285+05
24	8.640+09	3.420-01	9.442+10	8.771+02	1.615+00	3.054+00	2.016+10	8.033+09	3.772+05	1.313+05
25	9.000+09	3.402-01	9.742+10	8.990+02	1.623+00	3.070+00	2.098+10	8.369+09	3.813+05	1.340+05
26	9.360+09	3.385-01	1.004+11	9.210+02	1.630+00	3.086+00	2.180+10	8.705+09	3.853+05	1.367+05
27	9.720+09	3.368-01	1.033+11	9.430+02	1.637+00	3.102+00	2.261+10	9.041+09	3.892+05	1.393+05
28	1.008+10	3.352-01	1.063+11	9.650+02	1.644+00	3.117+00	2.343+10	9.377+09	3.930+05	1.419+05
29	1.044+10	3.336-01	1.092+11	9.870+02	1.651+00	3.132+00	2.425+10	9.713+09	3.966+05	1.444+05
30	1.080+10	3.321-01	1.120+11	1.009+03	1.658+00	3.146+00	2.507+10	1.005+10	4.002+05	1.469+05
31	1.116+10	3.306-01	1.149+11	1.031+03	1.664+00	3.161+00	2.588+10	1.039+10	4.037+05	1.493+05
32	1.152+10	3.292-01	1.177+11	1.053+03	1.670+00	3.175+00	2.670+10	1.072+10	4.072+05	1.517+05
33	1.188+10	3.277-01	1.206+11	1.075+03	1.676+00	3.189+00	2.752+10	1.106+10	4.105+05	1.541+05
34	1.224+10	3.264-01	1.234+11	1.097+03	1.682+00	3.203+00	2.834+10	1.139+10	4.138+05	1.564+05
35	1.260+10	3.250-01	1.261+11	1.119+03	1.688+00	3.216+00	2.916+10	1.173+10	4.170+05	1.587+05
36	1.296+10	3.237-01	1.289+11	1.141+03	1.694+00	3.229+00	2.998+10	1.206+10	4.202+05	1.609+05
37	1.332+10	3.223-01	1.322+11	1.161+03	1.689+00	3.245+00	3.055+10	1.241+10	4.241+05	1.635+05
38	1.368+10	3.213-01	1.339+11	1.189+03	1.707+00	3.253+00	3.175+10	1.273+10	4.258+05	1.650+05
39	1.404+10	3.199-01	1.376+11	1.206+03	1.700+00	3.271+00	3.220+10	1.308+10	4.301+05	1.679+05
40	1.440+10	3.187-01	1.404+11	1.228+03	1.705+00	3.283+00	3.300+10	1.342+10	4.331+05	1.700+05
41	1.476+10	3.178-01	1.426+11	1.253+03	1.706+00	3.293+00	3.386+10	1.375+10	4.356+05	1.718+05
42	1.512+10	3.166-01	1.453+11	1.276+03	1.709+00	3.306+00	3.469+10	1.409+10	4.385+05	1.738+05
43	1.548+10	3.155-01	1.480+11	1.298+03	1.713+00	3.318+00	3.544+10	1.443+10	4.413+05	1.759+05
44	1.584+10	3.144-01	1.506+11	1.321+03	1.717+00	3.330+00	3.626+10	1.477+10	4.441+05	1.779+05
45	1.620+10	3.133-01	1.533+11	1.343+03	1.722+00	3.342+00	3.707+10	1.510+10	4.468+05	1.799+05
46	1.656+10	3.123-01	1.559+11	1.366+03	1.726+00	3.353+00	3.788+10	1.544+10	4.495+05	1.819+05
47	1.692+10	3.112-01	1.585+11	1.388+03	1.730+00	3.365+00	3.869+10	1.577+10	4.522+05	1.839+05
48	1.728+10	3.102-01	1.611+11	1.411+03	1.734+00	3.376+00	3.951+10	1.611+10	4.548+05	1.859+05
49	1.764+10	3.092-01	1.637+11	1.433+03	1.738+00	3.387+00	4.032+10	1.645+10	4.574+05	1.878+05
50	1.800+10	3.082-01	1.663+11	1.456+03	1.742+00	3.399+00	4.113+10	1.678+10	4.599+05	1.897+05
51	1.836+10	3.073-01	1.689+11	1.478+03	1.745+00	3.410+00	4.195+10	1.712+10	4.624+05	1.916+05
52	1.872+10	3.063-01	1.715+11	1.501+03	1.749+00	3.421+00	4.277+10	1.745+10	4.649+05	1.935+05

TABLE B.5 (Continued)

5 Percent Water, 15 Percent Porosity Mixture (Continued)

53	1.908+10	3.054-01	1.740+11	1.524+03	1.753+00	3.431+00	4.358+10	1.779+10	4.674+05	1.953+05
54	1.944+10	3.045-01	1.766+11	1.546+03	1.756+00	3.442+00	4.440+10	1.813+10	4.698+05	1.972+05
55	1.980+10	3.036-01	1.791+11	1.569+03	1.760+00	3.453+00	4.522+10	1.846+10	4.722+05	1.990+05
56	2.016+10	3.027-01	1.816+11	1.592+03	1.763+00	3.463+00	4.603+10	1.880+10	4.746+05	2.008+05
57	2.052+10	3.018-01	1.842+11	1.615+03	1.767+00	3.474+00	4.685+10	1.913+10	4.769+05	2.026+05
58	2.088+10	3.009-01	1.867+11	1.638+03	1.770+00	3.484+00	4.767+10	1.947+10	4.792+05	2.043+05
59	2.124+10	3.001-01	1.892+11	1.661+03	1.774+00	3.494+00	4.849+10	1.981+10	4.815+05	2.061+05
60	2.160+10	2.992-01	1.918+11	1.683+03	1.774+00	3.505+00	4.924+10	2.015+10	4.839+05	2.079+05
61	2.196+10	2.984-01	1.943+11	1.706+03	1.778+00	3.515+00	5.006+10	2.048+10	4.862+05	2.096+05
62	2.232+10	2.976-01	1.968+11	1.729+03	1.781+00	3.525+00	5.088+10	2.082+10	4.884+05	2.114+05
63	2.268+10	2.968-01	1.993+11	1.752+03	1.784+00	3.535+00	5.171+10	2.115+10	4.906+05	2.131+05
64	2.304+10	2.960-01	2.017+11	1.775+03	1.787+00	3.544+00	5.253+10	2.149+10	4.928+05	2.147+05
65	2.340+10	2.952-01	2.042+11	1.798+03	1.790+00	3.554+00	5.335+10	2.182+10	4.950+05	2.164+05
66	2.376+10	2.945-01	2.066+11	1.821+03	1.793+00	3.564+00	5.417+10	2.216+10	4.971+05	2.181+05
67	2.412+10	2.937-01	2.091+11	1.844+03	1.796+00	3.573+00	5.500+10	2.249+10	4.992+05	2.197+05
68	2.448+10	2.930-01	2.115+11	1.867+03	1.799+00	3.583+00	5.582+10	2.283+10	5.013+05	2.214+05
69	2.484+10	2.922-01	2.140+11	1.890+03	1.802+00	3.592+00	5.665+10	2.317+10	5.034+05	2.230+05
70	2.520+10	2.915-01	2.164+11	1.913+03	1.805+00	3.601+00	5.747+10	2.350+10	5.055+05	2.246+05
71	2.556+10	2.908-01	2.188+11	1.937+03	1.808+00	3.611+00	5.830+10	2.384+10	5.075+05	2.262+05
72	2.592+10	2.901-01	2.213+11	1.960+03	1.810+00	3.620+00	5.913+10	2.417+10	5.095+05	2.278+05
73	2.628+10	2.894-01	2.237+11	1.983+03	1.813+00	3.629+00	5.996+10	2.451+10	5.115+05	2.294+05
74	2.664+10	2.887-01	2.261+11	2.007+03	1.816+00	3.638+00	6.079+10	2.484+10	5.135+05	2.310+05
75	2.700+10	2.880-01	2.285+11	2.030+03	1.819+00	3.647+00	6.161+10	2.518+10	5.155+05	2.325+05
76	2.736+10	2.873-01	2.309+11	2.053+03	1.821+00	3.656+00	6.245+10	2.551+10	5.175+05	2.341+05
77	2.772+10	2.867-01	2.333+11	2.077+03	1.824+00	3.664+00	6.328+10	2.585+10	5.194+05	2.356+05
78	2.808+10	2.860-01	2.357+11	2.100+03	1.826+00	3.673+00	6.411+10	2.618+10	5.214+05	2.371+05
79	2.844+10	2.854-01	2.380+11	2.124+03	1.829+00	3.682+00	6.494+10	2.652+10	5.233+05	2.386+05
80	2.880+10	2.847-01	2.404+11	2.147+03	1.831+00	3.690+00	6.577+10	2.685+10	5.252+05	2.402+05
81	2.916+10	2.841-01	2.428+11	2.171+03	1.834+00	3.699+00	6.661+10	2.719+10	5.271+05	2.417+05
82	2.952+10	2.835-01	2.451+11	2.194+03	1.836+00	3.708+00	6.744+10	2.752+10	5.289+05	2.431+05
83	2.988+10	2.828-01	2.475+11	2.218+03	1.839+00	3.716+00	6.828+10	2.786+10	5.308+05	2.446+05
84	3.024+10	2.822-01	2.499+11	2.242+03	1.841+00	3.724+00	6.911+10	2.819+10	5.326+05	2.461+05
85	3.060+10	2.816-01	2.522+11	2.265+03	1.844+00	3.733+00	6.995+10	2.853+10	5.345+05	2.476+05
86	3.096+10	2.810-01	2.546+11	2.289+03	1.846+00	3.741+00	7.079+10	2.886+10	5.363+05	2.490+05
87	3.132+10	2.804-01	2.569+11	2.313+03	1.848+00	3.749+00	7.163+10	2.920+10	5.381+05	2.505+05
88	3.168+10	2.798-01	2.592+11	2.337+03	1.851+00	3.757+00	7.247+10	2.953+10	5.399+05	2.519+05
89	3.204+10	2.793-01	2.616+11	2.360+03	1.853+00	3.766+00	7.331+10	2.987+10	5.417+05	2.533+05
90	3.240+10	2.787-01	2.639+11	2.384+03	1.855+00	3.774+00	7.415+10	3.020+10	5.434+05	2.547+05
91	3.276+10	2.781-01	2.662+11	2.408+03	1.858+00	3.782+00	7.499+10	3.054+10	5.452+05	2.562+05
92	3.312+10	2.776-01	2.685+11	2.432+03	1.860+00	3.790+00	7.583+10	3.087+10	5.470+05	2.576+05
93	3.348+10	2.770-01	2.709+11	2.456+03	1.862+00	3.798+00	7.667+10	3.121+10	5.487+05	2.590+05
94	3.384+10	2.765-01	2.732+11	2.480+03	1.864+00	3.805+00	7.752+10	3.154+10	5.504+05	2.604+05
95	3.420+10	2.759-01	2.755+11	2.504+03	1.866+00	3.813+00	7.836+10	3.188+10	5.521+05	2.617+05
96	3.456+10	2.754-01	2.778+11	2.528+03	1.869+00	3.821+00	7.921+10	3.221+10	5.538+05	2.631+05
97	3.492+10	2.748-01	2.801+11	2.552+03	1.871+00	3.829+00	8.005+10	3.254+10	5.555+05	2.645+05
98	3.528+10	2.743-01	2.824+11	2.576+03	1.873+00	3.837+00	8.090+10	3.288+10	5.572+05	2.659+05
99	3.564+10	2.738-01	2.847+11	2.600+03	1.875+00	3.844+00	8.175+10	3.321+10	5.589+05	2.672+05
100	3.600+10	2.733-01	2.869+11	2.624+03	1.877+00	3.852+00	8.259+10	3.355+10	5.605+05	2.686+05
101	3.636+10	2.728-01	2.892+11	2.648+03	1.879+00	3.859+00	8.344+10	3.388+10	5.622+05	2.699+05
102	3.672+10	2.723-01	2.915+11	2.672+03	1.881+00	3.867+00	8.429+10	3.422+10	5.638+05	2.712+05
103	3.708+10	2.718-01	2.938+11	2.697+03	1.883+00	3.874+00	8.514+10	3.455+10	5.655+05	2.726+05
104	3.744+10	2.713-01	2.961+11	2.721+03	1.885+00	3.882+00	8.599+10	3.488+10	5.671+05	2.739+05
105	3.780+10	2.708-01	2.983+11	2.745+03	1.887+00	3.889+00	8.685+10	3.522+10	5.687+05	2.752+05
106	3.816+10	2.703-01	3.006+11	2.770+03	1.889+00	3.897+00	6.770+10	3.555+10	5.703+05	2.765+05

TABLE B.5 (Continued)

5 PERCENT WATER, 10 PERCENT POROSITY MIXTURE

K	AIX	TVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	4.223-01	9.843+09	3.302+02	1.227+00	2.490+00	5.122+08	3.520+08	1.818+05	2.683+04
2	7.200+08	4.108-01	1.695+10	3.577+02	1.307+00	2.550+00	1.371+09	6.858+08	2.217+05	3.788+04
3	1.080+09	4.023-01	2.317+10	3.819+02	1.354+00	2.600+00	2.212+09	1.020+09	2.471+05	4.647+04
4	1.440+09	3.953-01	2.874+10	4.046+02	1.393+00	2.643+00	3.048+09	1.355+09	2.654+05	5.365+04
5	1.800+09	3.894-01	3.390+10	4.264+02	1.425+00	2.682+00	3.874+09	1.691+09	2.800+05	5.998+04
6	2.160+09	3.841-01	3.876+10	4.474+02	1.453+00	2.717+00	4.692+09	2.027+09	2.923+05	6.570+04
7	2.520+09	3.794-01	4.340+10	4.680+02	1.477+00	2.749+00	5.503+09	2.363+09	3.030+05	7.096+04
8	2.880+09	3.752-01	4.784+10	4.883+02	1.498+00	2.780+00	6.309+09	2.700+09	3.124+05	7.586+04
9	3.240+09	3.713-01	5.212+10	5.083+02	1.517+00	2.808+00	7.110+09	3.036+09	3.209+05	8.046+04
10	3.600+09	3.676-01	5.627+10	5.282+02	1.535+00	2.835+00	7.909+09	3.373+09	3.287+05	8.482+04
11	3.960+09	3.643-01	6.031+10	5.479+02	1.552+00	2.861+00	8.705+09	3.710+09	3.359+05	8.895+04
12	4.320+09	3.613-01	6.408+10	5.684+02	1.564+00	2.885+00	9.495+09	4.048+09	3.424+05	9.272+04
13	4.680+09	3.581-01	6.809+10	5.870+02	1.581+00	2.909+00	1.029+10	4.385+09	3.489+05	9.670+04
14	5.040+09	3.555-01	7.172+10	6.074+02	1.591+00	2.931+00	1.107+10	4.723+09	3.547+05	1.002+05
15	5.400+09	3.529-01	7.540+10	6.270+02	1.604+00	2.953+00	1.185+10	5.060+09	3.603+05	1.037+05
16	5.760+09	3.503-01	7.904+10	6.464+02	1.615+00	2.975+00	1.264+10	5.398+09	3.656+05	1.071+05
17	6.120+09	3.479-01	8.263+10	6.658+02	1.627+00	2.995+00	1.342+10	5.736+09	3.708+05	1.104+05
18	6.480+09	3.456-01	8.616+10	6.852+02	1.638+00	3.015+00	1.420+10	6.073+09	3.757+05	1.136+05
19	6.840+09	3.434-01	8.964+10	7.046+02	1.648+00	3.035+00	1.499+10	6.411+09	3.804+05	1.168+05
20	7.200+09	3.412-01	9.308+10	7.241+02	1.658+00	3.054+00	1.577+10	6.749+09	3.849+05	1.198+05
21	7.560+09	3.392-01	9.647+10	7.435+02	1.667+00	3.072+00	1.655+10	7.087+09	3.893+05	1.228+05
22	7.920+09	3.372-01	9.982+10	7.630+02	1.677+00	3.090+00	1.733+10	7.424+09	3.935+05	1.257+05
23	8.280+09	3.353-01	1.031+11	7.825+02	1.685+00	3.108+00	1.812+10	7.762+09	3.976+05	1.285+05
24	8.640+09	3.335-01	1.064+11	8.021+02	1.694+00	3.125+00	1.890+10	8.100+09	4.016+05	1.313+05
25	9.000+09	3.317-01	1.097+11	8.216+02	1.702+00	3.142+00	1.963+10	8.438+09	4.055+05	1.340+05
26	9.360+09	3.300-01	1.129+11	8.413+02	1.710+00	3.159+00	2.047+10	8.775+09	4.092+05	1.367+05
27	9.720+09	3.283-01	1.161+11	8.609+02	1.718+00	3.175+00	2.125+10	9.113+09	4.129+05	1.393+05
28	1.008+10	3.267-01	1.192+11	8.806+02	1.725+00	3.191+00	2.204+10	9.451+09	4.165+05	1.418+05
29	1.044+10	3.251-01	1.224+11	9.004+02	1.733+00	3.206+00	2.282+10	9.788+09	4.199+05	1.444+05
30	1.080+10	3.236-01	1.255+11	9.202+02	1.740+00	3.222+00	2.361+10	1.013+10	4.234+05	1.468+05
31	1.116+10	3.221-01	1.286+11	9.400+02	1.747+00	3.237+00	2.439+10	1.046+10	4.267+05	1.493+05
32	1.152+10	3.207-01	1.316+11	9.599+02	1.753+00	3.252+00	2.518+10	1.080+10	4.300+05	1.517+05
33	1.188+10	3.193-01	1.347+11	9.799+02	1.760+00	3.266+00	2.597+10	1.114+10	4.332+05	1.540+05
34	1.224+10	3.179-01	1.377+11	9.999+02	1.766+00	3.280+00	2.676+10	1.148+10	4.363+05	1.564+05
35	1.260+10	3.166-01	1.407+11	1.020+03	1.772+00	3.295+00	2.755+10	1.181+10	4.394+05	1.586+05
36	1.296+10	3.153-01	1.437+11	1.040+03	1.778+00	3.308+00	2.834+10	1.215+10	4.424+05	1.609+05
37	1.332+10	3.140-01	1.466+11	1.060+03	1.784+00	3.322+00	2.913+10	1.249+10	4.453+05	1.631+05
38	1.368+10	3.127-01	1.496+11	1.080+03	1.790+00	3.336+00	2.992+10	1.283+10	4.483+05	1.653+05
39	1.404+10	3.115-01	1.525+11	1.101+03	1.796+00	3.349+00	3.071+10	1.316+10	4.511+05	1.675+05
40	1.440+10	3.103-01	1.554+11	1.121+03	1.801+00	3.362+00	3.150+10	1.350+10	4.539+05	1.696+05
41	1.476+10	3.092-01	1.583+11	1.141+03	1.807+00	3.375+00	3.230+10	1.384+10	4.567+05	1.717+05
42	1.512+10	3.080-01	1.612+11	1.162+03	1.812+00	3.388+00	3.309+10	1.417+10	4.595+05	1.738+05
43	1.548+10	3.069-01	1.640+11	1.182+03	1.817+00	3.400+00	3.389+10	1.451+10	4.621+05	1.759+05
44	1.584+10	3.058-01	1.669+11	1.202+03	1.822+00	3.413+00	3.468+10	1.485+10	4.648+05	1.779+05
45	1.620+10	3.047-01	1.697+11	1.223+03	1.827+00	3.425+00	3.548+10	1.519+10	4.674+05	1.799+05
46	1.656+10	3.037-01	1.726+11	1.244+03	1.832+00	3.437+00	3.628+10	1.552+10	4.700+05	1.819+05
47	1.692+10	3.027-01	1.754+11	1.264+03	1.837+00	3.449+00	3.708+10	1.586+10	4.725+05	1.839+05
48	1.728+10	3.016-01	1.782+11	1.285+03	1.842+00	3.461+00	3.788+10	1.620+10	4.750+05	1.858+05
49	1.764+10	3.006-01	1.810+11	1.306+03	1.846+00	3.473+00	3.868+10	1.653+10	4.775+05	1.878+05

TABLE B.5 (Continued)

5 Percent Water, 10 Percent Porosity Mixture (Continued)

50	1.800+10	2.997-01	1.837+11	1.324+03	1.851+00	3.484+00	3.948+10	1.687+10	4.800+05	1.897+05
51	1.836+10	2.987-01	1.865+11	1.347+03	1.855+00	3.496+00	4.028+10	1.721+10	4.824+05	1.916+05
52	1.872+10	2.978-01	1.893+11	1.368+03	1.860+00	3.507+00	4.108+10	1.754+10	4.848+05	1.934+05
53	1.908+10	2.968-01	1.920+11	1.389+03	1.864+00	3.518+00	4.189+10	1.788+10	4.871+05	1.953+05
54	1.944+10	2.959-01	1.947+11	1.410+03	1.868+00	3.530+00	4.269+10	1.822+10	4.895+05	1.971+05
55	1.980+10	2.950-01	1.975+11	1.431+03	1.872+00	3.541+00	4.350+10	1.855+10	4.918+05	1.990+05
56	2.016+10	2.941-01	2.002+11	1.452+03	1.877+00	3.551+00	4.430+10	1.889+10	4.941+05	2.008+05
57	2.052+10	2.933-01	2.029+11	1.473+03	1.881+00	3.562+00	4.511+10	1.923+10	4.963+05	2.025+05
58	2.088+10	2.924-01	2.056+11	1.494+03	1.885+00	3.573+00	4.592+10	1.956+10	4.985+05	2.043+05
59	2.124+10	2.916-01	2.083+11	1.515+03	1.889+00	3.584+00	4.673+10	1.990+10	5.006+05	2.061+05
60	2.160+10	2.909-01	2.104+11	1.540+03	1.892+00	3.592+00	4.763+10	2.023+10	5.024+05	2.075+05
61	2.196+10	2.901-01	2.139+11	1.559+03	1.876+00	3.606+00	4.777+10	2.060+10	5.057+05	2.096+05
62	2.232+10	2.893-01	2.165+11	1.581+03	1.879+00	3.616+00	4.858+10	2.094+10	5.078+05	2.113+05
63	2.268+10	2.886-01	2.192+11	1.602+03	1.882+00	3.626+00	4.937+10	2.128+10	5.100+05	2.130+05
64	2.304+10	2.878-01	2.218+11	1.624+03	1.885+00	3.636+00	5.017+10	2.161+10	5.121+05	2.146+05
65	2.340+10	2.870-01	2.246+11	1.644+03	1.889+00	3.647+00	5.094+10	2.195+10	5.143+05	2.164+05
66	2.376+10	2.862-01	2.273+11	1.665+03	1.893+00	3.657+00	5.176+10	2.229+10	5.163+05	2.181+05
67	2.412+10	2.854-01	2.299+11	1.687+03	1.896+00	3.667+00	5.257+10	2.262+10	5.184+05	2.197+05
68	2.448+10	2.847-01	2.325+11	1.709+03	1.900+00	3.677+00	5.337+10	2.296+10	5.204+05	2.214+05
69	2.484+10	2.840-01	2.351+11	1.730+03	1.903+00	3.686+00	5.417+10	2.330+10	5.224+05	2.230+05
70	2.520+10	2.833-01	2.377+11	1.752+03	1.906+00	3.696+00	5.498+10	2.363+10	5.244+05	2.246+05
71	2.556+10	2.826-01	2.403+11	1.774+03	1.909+00	3.706+00	5.579+10	2.397+10	5.264+05	2.262+05
72	2.592+10	2.819-01	2.429+11	1.795+03	1.912+00	3.715+00	5.659+10	2.431+10	5.284+05	2.278+05
73	2.628+10	2.812-01	2.455+11	1.817+03	1.915+00	3.725+00	5.740+10	2.464+10	5.303+05	2.294+05
74	2.664+10	2.805-01	2.481+11	1.839+03	1.918+00	3.734+00	5.821+10	2.498+10	5.323+05	2.309+05
75	2.700+10	2.798-01	2.507+11	1.861+03	1.921+00	3.743+00	5.902+10	2.531+10	5.342+05	2.325+05
76	2.736+10	2.792-01	2.532+11	1.883+03	1.924+00	3.752+00	5.983+10	2.565+10	5.361+05	2.341+05
77	2.772+10	2.785-01	2.558+11	1.905+03	1.927+00	3.762+00	6.064+10	2.599+10	5.380+05	2.356+05
78	2.808+10	2.778-01	2.584+11	1.927+03	1.930+00	3.771+00	6.146+10	2.632+10	5.398+05	2.371+05
79	2.844+10	2.772-01	2.609+11	1.949+03	1.933+00	3.780+00	6.227+10	2.666+10	5.417+05	2.386+05
80	2.880+10	2.766-01	2.634+11	1.971+03	1.935+00	3.789+00	6.308+10	2.700+10	5.436+05	2.401+05
81	2.916+10	2.760-01	2.660+11	1.993+03	1.938+00	3.798+00	6.390+10	2.733+10	5.454+05	2.416+05
82	2.952+10	2.753-01	2.685+11	2.015+03	1.941+00	3.806+00	6.472+10	2.767+10	5.472+05	2.431+05
83	2.988+10	2.747-01	2.710+11	2.037+03	1.944+00	3.815+00	6.553+10	2.800+10	5.490+05	2.446+05
84	3.024+10	2.741-01	2.736+11	2.060+03	1.946+00	3.824+00	6.635+10	2.834+10	5.508+05	2.461+05
85	3.060+10	2.735-01	2.761+11	2.082+03	1.949+00	3.833+00	6.717+10	2.868+10	5.526+05	2.475+05
86	3.096+10	2.729-01	2.786+11	2.104+03	1.952+00	3.841+00	6.799+10	2.901+10	5.544+05	2.490+05
87	3.132+10	2.724-01	2.811+11	2.127+03	1.954+00	3.850+00	6.881+10	2.935+10	5.561+05	2.504+05
88	3.168+10	2.718-01	2.836+11	2.149+03	1.957+00	3.858+00	6.963+10	2.968+10	5.579+05	2.519+05
89	3.204+10	2.712-01	2.861+11	2.171+03	1.959+00	3.867+00	7.045+10	3.002+10	5.596+05	2.533+05
90	3.240+10	2.706-01	2.886+11	2.194+03	1.962+00	3.875+00	7.128+10	3.035+10	5.613+05	2.547+05
91	3.276+10	2.701-01	2.911+11	2.216+03	1.964+00	3.883+00	7.210+10	3.069+10	5.630+05	2.561+05
92	3.312+10	2.695-01	2.935+11	2.239+03	1.967+00	3.892+00	7.293+10	3.102+10	5.647+05	2.575+05
93	3.348+10	2.690-01	2.960+11	2.262+03	1.969+00	3.900+00	7.375+10	3.136+10	5.664+05	2.589+05
94	3.384+10	2.684-01	2.985+11	2.284+03	1.972+00	3.908+00	7.458+10	3.170+10	5.681+05	2.603+05
95	3.420+10	2.679-01	3.010+11	2.307+03	1.974+00	3.916+00	7.541+10	3.203+10	5.698+05	2.617+05

TABLE B.5 (Continued)

5 PERCENT WATER, 5 PERCENT POROSITY MIXTURE

K	AIX	IVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	4.159-01	1.345+10	3.256+02	1.276+00	2.522+00	3.231+08	3.619+08	2.353+05	2.683+04
2	7.200+08	4.032-01	2.185+10	3.468+02	1.365+00	2.591+00	1.088+09	7.006+08	2.698+05	3.802+04
3	1.080+09	3.944-01	2.871+10	3.659+02	1.418+00	2.645+00	1.872+09	1.038+09	2.905+05	4.639+04
4	1.440+09	3.872-01	3.502+10	3.834+02	1.454+00	2.692+00	2.609+09	1.378+09	3.065+05	5.365+04
5	1.800+09	3.811-01	4.074+10	4.004+02	1.488+00	2.734+00	3.370+09	1.717+09	3.189+05	5.997+04
6	2.160+09	3.758-01	4.610+10	4.171+02	1.517+00	2.771+00	4.129+09	2.056+09	3.294+05	6.570+04
7	2.520+09	3.710-01	5.118+10	4.336+02	1.542+00	2.806+00	4.886+09	2.395+09	3.386+05	7.096+04
8	2.880+09	3.657-01	5.604+10	4.499+02	1.565+00	2.838+00	5.641+09	2.735+09	3.468+05	7.586+04
9	3.240+09	3.628-01	6.072+10	4.662+02	1.586+00	2.868+00	6.395+09	3.074+09	3.542+05	8.046+04
10	3.600+09	3.591-01	6.524+10	4.824+02	1.605+00	2.896+00	7.147+09	3.413+09	3.611+05	8.481+04
11	3.960+09	3.558-01	6.963+10	4.987+02	1.622+00	2.924+00	7.899+09	3.753+09	3.674+05	8.895+04
12	4.320+09	3.526-01	7.390+10	5.149+02	1.638+00	2.950+00	8.649+09	4.092+09	3.734+05	9.290+04
13	4.680+09	3.498-01	7.790+10	5.324+02	1.649+00	2.973+00	9.373+09	4.433+09	3.789+05	9.651+04
14	5.040+09	3.469-01	8.216+10	5.476+02	1.667+00	2.998+00	1.015+10	4.771+09	3.843+05	1.003+05
15	5.400+09	3.444-01	8.602+10	5.651+02	1.676+00	3.020+00	1.086+10	5.113+09	3.893+05	1.037+05
16	5.760+09	3.419-01	8.993+10	5.817+02	1.688+00	3.043+00	1.160+10	5.453+09	3.942+05	1.071+05
17	6.120+09	3.395-01	9.380+10	5.983+02	1.700+00	3.064+00	1.234+10	5.792+09	3.988+05	1.104+05
18	6.480+09	3.372-01	9.762+10	6.148+02	1.711+00	3.085+00	1.309+10	6.132+09	4.033+05	1.136+05
19	6.840+09	3.350-01	1.014+11	6.315+02	1.722+00	3.105+00	1.383+10	6.472+09	4.076+05	1.167+05
20	7.200+09	3.328-01	1.051+11	6.482+02	1.732+00	3.125+00	1.457+10	6.812+09	4.118+05	1.198+05
21	7.560+09	3.308-01	1.087+11	6.650+02	1.742+00	3.145+00	1.532+10	7.152+09	4.158+05	1.228+05
22	7.920+09	3.289-01	1.124+11	6.819+02	1.751+00	3.163+00	1.606+10	7.491+09	4.197+05	1.257+05
23	8.280+09	3.270-01	1.159+11	6.989+02	1.760+00	3.182+00	1.681+10	7.831+09	4.235+05	1.285+05
24	8.640+09	3.252-01	1.195+11	7.160+02	1.769+00	3.200+00	1.756+10	8.171+09	4.272+05	1.313+05
25	9.000+09	3.234-01	1.230+11	7.331+02	1.778+00	3.217+00	1.830+10	8.510+09	4.308+05	1.340+05
26	9.360+09	3.217-01	1.264+11	7.504+02	1.786+00	3.235+00	1.905+10	8.850+09	4.343+05	1.367+05
27	9.720+09	3.201-01	1.299+11	7.677+02	1.794+00	3.251+00	1.980+10	9.190+09	4.377+05	1.393+05
28	1.008+10	3.185-01	1.333+11	7.850+02	1.801+00	3.268+00	2.055+10	9.529+09	4.411+05	1.418+05
29	1.044+10	3.169-01	1.366+11	8.025+02	1.809+00	3.284+00	2.130+10	9.869+09	4.443+05	1.443+05
30	1.080+10	3.154-01	1.400+11	8.201+02	1.816+00	3.300+00	2.205+10	1.021+10	4.475+05	1.[illegible]68+05
31	1.116+10	3.139-01	1.433+11	8.377+02	1.823+00	3.316+00	2.280+10	1.055+10	4.507+05	1.493+05
32	1.152+10	3.125-01	1.466+11	8.554+02	1.830+00	3.331+00	2.355+10	1.089+10	4.537+05	1.516+05
33	1.188+10	3.111-01	1.499+11	8.732+02	1.837+00	3.346+00	2.431+10	1.123+10	4.568+05	1.540+05
34	1.224+10	3.098-01	1.531+11	8.910+02	1.843+00	3.361+00	2.506+10	1.157+10	4.597+05	1.563+05
35	1.260+10	3.085-01	1.563+11	9.090+02	1.849+00	3.376+00	2.582+10	1.190+10	4.626+05	1.586+05
36	1.296+10	3.072-01	1.595+11	9.270+02	1.856+00	3.390+00	2.657+10	1.224+10	4.655+05	1.609+05
37	1.332+10	3.059-01	1.627+11	9.451+02	1.862+00	3.404+00	2.733+10	1.258+10	4.683+05	1.631+05
38	1.368+10	3.047-01	1.659+11	9.632+02	1.868+00	3.418+00	2.809+10	1.292+10	4.710+05	1.653+05
39	1.404+10	3.035-01	1.690+11	9.815+02	1.873+00	3.432+00	2.885+10	1.326+10	4.738+05	1.675+05
40	1.440+10	3.023-01	1.721+11	9.998+02	1.879+00	3.446+00	2.961+10	1.360+10	4.764+05	1.696+05
41	1.476+10	3.012-01	1.752+11	1.018+03	1.884+00	3.459+00	3.037+10	1.394+10	4.791+05	1.717+05
42	1.512+10	3.000-01	1.783+11	1.037+03	1.890+00	3.472+00	3.114+10	1.428+10	4.817+05	1.738+05
43	1.548+10	2.989-01	1.814+11	1.055+03	1.895+00	3.486+00	3.190+10	1.462+10	4.842+05	1.758+05
44	1.584+10	2.979-01	1.845+11	1.074+03	1.900+00	3.498+00	3.266+10	1.495+10	4.868+05	1.779+05
45	1.620+10	2.968-01	1.875+11	1.092+03	1.905+00	3.511+00	3.343+10	1.529+10	4.893+05	1.799+05
46	1.656+10	2.958-01	1.905+11	1.111+03	1.910+00	3.524+00	3.420+10	1.563+10	4.917+05	1.819+05
47	1.692+10	2.947-01	1.936+11	1.130+03	1.915+00	3.536+00	3.497+10	1.597+10	4.942+05	1.839+05
48	1.728+10	2.938-01	1.966+11	1.149+03	1.920+00	3.549+00	3.574+10	1.631+10	4.966+05	1.858+05
49	1.764+10	2.928-01	1.995+11	1.168+03	1.925+00	3.561+00	3.651+10	1.665+10	4.989+05	1.877+05

TABLE B.5 (Continued)

5 Percent Water, 5 Percent Porosity Mixture (Continued)

50	1.803+10	2.918-01	2.025+11	1.187+03	1.929+00	3.573+00	3.728+10	1.699+10	5.013+05	1.896+05
51	1.836+10	2.909-01	2.055+11	1.206+03	1.934+00	3.585+00	3.805+10	1.732+10	5.03[illegible]+05	1.915+05
52	1.872+10	2.899-01	2.084+11	1.225+03	1.938+00	3.597+00	3.882+10	1.766+10	5.059+05	1.934+05
53	1.908+10	2.890-01	2.114+11	1.244+03	1.943+00	3.608+00	3.960+10	1.800+10	5.081+05	1.953+05
54	1.944+10	2.881-01	2.143+11	1.263+03	1.947+00	3.620+00	4.037+10	1.834+10	5.104+05	1.971+05
55	1.980+10	2.872-01	2.172+11	1.282+03	1.952+00	3.631+00	4.115+10	1.868+10	5.126+05	1.989+05
56	2.016+10	2.864-01	2.201+11	1.302+03	1.956+00	3.642+00	4.193+10	1.901+10	5.148+05	2.007+05
57	2.052+10	2.855-01	2.230+11	1.321+03	1.960+00	3.654+00	4.271+10	1.935+10	5.170+05	2.025+05
58	2.088+10	2.847-01	2.259+11	1.341+03	1.964+00	3.665+00	4.349+10	1.969+10	5.191+05	2.043+05
59	2.124+10	2.839-01	2.288+11	1.360+03	1.968+00	3.676+00	4.427+10	2.003+10	5.212+05	2.060+05
60	2.160+10	2.830-01	2.317+11	1.380+03	1.972+00	3.687+00	4.505+10	2.037+10	5.233+05	2.078+05
61	2.196+10	2.822-01	2.345+11	1.399+03	1.976+00	3.697+00	4.583+10	2.070+10	5.254+05	2.095+05
62	2.232+10	2.815-01	2.374+11	1.419+03	1.980+00	3.708+00	4.662+10	2.104+10	5.275+05	2.112+05
63	2.268+10	2.807-01	2.402+11	1.439+03	1.984+00	3.719+00	4.740+10	2.138+10	5.296+05	2.129+05
64	2.304+10	2.799-01	2.430+11	1.459+03	1.987+00	3.729+00	4.819+10	2.172+10	5.316+05	2.146+05
65	2.340+10	2.791-01	2.458+11	1.478+03	1.991+00	3.740+00	4.898+10	2.205+10	5.336+05	2.163+05
66	2.376+10	2.784-01	2.487+11	1.498+03	1.995+00	3.750+00	4.977+10	2.239+10	5.356+05	2.179+05
67	2.412+10	2.777-01	2.515+11	1.518+03	1.998+00	3.760+00	5.056+10	2.273+10	5.376+05	2.196+05
68	2.448+10	2.769-01	2.543+11	1.538+03	2.002+00	3.770+00	5.135+10	2.307+10	5.395+05	2.212+05
69	2.484+10	2.762-01	2.570+11	1.558+03	2.005+00	3.780+00	5.214+10	2.340+10	5.415+05	2.228+05
70	2.520+10	2.755-01	2.598+11	1.579+03	2.009+00	3.790+00	5.293+10	2.374+10	5.434+05	2.244+05
71	2.556+10	2.748-01	2.626+11	1.599+03	2.012+00	3.800+00	5.373+10	2.408+10	5.453+05	2.260+05
72	2.592+10	2.741-01	2.654+11	1.619+03	2.016+00	3.810+00	5.452+10	2.441+10	5.472+05	2.276+05
73	2.628+10	2.735-01	2.681+11	1.639+03	2.019+00	3.820+00	5.532+10	2.475+10	5.491+05	2.292+05
74	2.664+10	2.728-01	2.709+11	1.660+03	2.022+00	3.830+00	5.612+10	2.509+10	5.510+05	2.308+05
75	2.700+10	2.721-01	2.736+11	1.680+03	2.026+00	3.839+00	5.692+10	2.543+10	5.528+05	2.323+05
76	2.736+10	2.715-01	2.763+11	1.701+03	2.029+00	3.849+00	5.772+10	2.576+10	5.547+05	2.339+05
77	2.772+10	2.708-01	2.791+11	1.721+03	2.032+00	3.858+00	5.852+10	2.610+10	5.565+05	2.354+05
78	2.808+10	2.702-01	2.818+11	1.742+03	2.035+00	3.868+00	5.932+10	2.644+10	5.583+05	2.369+05
79	2.844+10	2.696-01	2.845+11	1.762+03	2.039+00	3.877+00	6.012+10	2.677+10	5.601+05	2.384+05
80	2.880+10	2.689-01	2.872+11	1.783+03	2.042+00	3.886+00	6.093+10	2.711+10	5.619+05	2.399+05
81	2.916+10	2.683-01	2.899+11	1.804+03	2.045+00	3.895+00	6.173+10	2.745+10	5.637+05	2.41[illegible]+05
82	2.952+10	2.677-01	2.926+11	1.824+03	2.048+00	3.905+00	6.254+10	2.778+10	5.654+05	2.429+05
83	2.988+10	2.671-01	2.953+11	1.845+03	2.051+00	3.914+00	6.335+10	2.812+10	5.672+05	2.444+05
84	3.024+10	2.665-01	2.980+11	1.866+03	2.054+00	3.[illegible]23+00	6.416+10	2.845+10	5.689+05	2.459+05
85	3.060+10	2.659-01	3.007+11	1.887+03	2.057+00	3.932+00	6.497+10	2.879+10	5.706+05	2.473+05

TABLE B.5 (Continued)

15 PERCENT WATER, 20 PERCENT POROSITY MIXTURE

#	AIX	TVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	9.801-01	4.764+09	3.293+02	1.135+00	2.443+00	6.683+08	3.056+08	1.122+05	2.677+04
2	7.200+08	9.685-01	8.884+09	3.590+02	1.194+00	2.479+00	1.505+09	5.815+08	1.476+05	3.794+04
3	1.080+09	9.600-01	1.266+10	3.868+02	1.234+00	2.511+00	2.350+09	8.559+08	1.718+05	4.647+04
4	1.440+09	9.531-01	1.623+10	4.133+02	1.265+00	2.541+00	3.189+09	1.131+09	1.907+05	5.366+04
5	1.800+09	9.473-01	1.964+10	4.389+02	1.291+00	2.568+00	4.019+09	1.408+09	2.064+05	5.999+04
6	2.160+09	9.421-01	2.292+10	4.639+02	1.312+00	2.593+00	4.841+09	1.687+09	2.199+05	6.572+04
7	2.520+09	9.375-01	2.610+10	4.883+02	1.330+00	2.618+00	5.655+09	1.967+09	2.318+05	7.098+04
8	2.880+09	9.335-01	2.909+10	5.126+02	1.346+00	2.640+00	6.466+09	2.247+09	2.422+05	7.572+04
9	3.240+09	9.296-01	3.210+10	5.363+02	1.360+00	2.662+00	7.266+09	2.530+09	2.520+05	8.032+04
10	3.600+09	9.260-01	3.505+10	5.597+02	1.374+00	2.683+00	8.059+09	2.813+09	2.610+05	8.468+04
11	3.960+09	9.226-01	3.795+10	5.828+02	1.386+00	2.703+00	8.847+09	3.098+09	2.694+05	8.883+04
12	4.320+09	9.195-01	4.079+10	6.057+02	1.398+00	2.723+00	9.630+09	3.383+09	2.772+05	9.279+04
13	4.680+09	9.165-01	4.359+10	6.284+02	1.408+00	2.742+00	1.041+10	3.669+09	2.845+05	9.660+04
14	5.040+09	9.137-01	4.634+10	6.510+02	1.418+00	2.761+00	1.118+10	3.956+09	2.915+05	1.003+05
15	5.400+09	9.110-01	4.906+10	6.734+02	1.428+00	2.779+00	1.195+10	4.244+09	2.980+05	1.038+05
16	5.760+09	9.084-01	5.174+10	6.957+02	1.437+00	2.796+00	1.272+10	4.532+09	3.043+05	1.072+05
17	6.120+09	9.060-01	5.438+10	7.179+02	1.445+00	2.813+00	1.349+10	4.820+09	3.103+05	1.105+05
18	6.480+09	9.036-01	5.700+10	7.400+02	1.453+00	2.829+00	1.425+10	5.109+09	3.160+05	1.137+05
19	6.840+09	9.014-01	5.958+10	7.620+02	1.461+00	2.846+00	1.501+10	5.399+09	3.215+05	1.168+05
20	7.200+09	8.992-01	6.214+10	7.839+02	1.468+00	2.861+00	1.576+10	5.689+09	3.268+05	1.199+05
21	7.560+09	8.972-01	6.467+10	8.057+02	1.475+00	2.877+00	1.652+10	5.979+09	3.319+05	1.229+05
22	7.920+09	8.952-01	6.718+10	8.275+02	1.482+00	2.892+00	1.727+10	6.270+09	3.369+05	1.258+05
23	8.280+09	8.932-01	6.967+10	8.492+02	1.488+00	2.907+00	1.802+10	6.560+09	3.416+05	1.286+05
24	8.640+09	8.913-01	7.214+10	8.709+02	1.494+00	2.921+00	1.877+10	6.852+09	3.463+05	1.314+05
25	9.000+09	8.895-01	7.459+10	8.925+02	1.500+00	2.936+00	1.952+10	7.143+09	3.508+05	1.341+05
26	9.360+09	8.878-01	7.702+10	9.141+02	1.506+00	2.950+00	2.027+10	7.435+09	3.551+05	1.367+05
27	9.720+09	8.861-01	7.943+10	9.356+02	1.512+00	2.963+00	2.102+10	7.726+09	3.594+05	1.393+05
28	1.008+10	8.844-01	8.182+10	9.572+02	1.517+00	2.977+00	2.176+10	8.018+09	3.635+05	1.419+05
29	1.044+10	8.828-01	8.420+10	9.786+02	1.522+00	2.990+00	2.251+10	8.311+09	3.676+05	1.444+05
30	1.080+10	8.812-01	8.656+10	1.000+03	1.528+00	3.003+00	2.325+10	8.603+09	3.715+05	1.469+05
31	1.116+10	8.797-01	8.891+10	1.022+03	1.533+00	3.016+00	2.399+10	8.895+09	3.754+05	1.493+05
32	1.152+10	8.782-01	9.124+10	1.043+03	1.537+00	3.029+00	2.473+10	9.188+09	3.792+05	1.517+05
33	1.188+10	8.768-01	9.356+10	1.064+03	1.542+00	3.041+00	2.548+10	9.481+09	3.828+05	1.541+05
34	1.224+10	8.753-01	9.587+10	1.086+03	1.547+00	3.054+00	2.622+10	9.774+09	3.865+05	1.564+05
35	1.260+10	8.740-01	9.816+10	1.107+03	1.551+00	3.066+00	2.696+10	1.007+10	3.900+05	1.587+05
36	1.296+10	8.726-01	1.004+11	1.128+03	1.556+00	3.078+00	2.770+10	1.036+10	3.935+05	1.610+05
37	1.332+10	8.713-01	1.027+11	1.150+03	1.560+00	3.089+00	2.844+10	1.065+10	3.969+05	1.632+05
38	1.368+10	8.700-01	1.050+11	1.171+03	1.564+00	3.101+00	2.917+10	1.095+10	4.002+05	1.654+05
39	1.404+10	8.687-01	1.072+11	1.192+03	1.568+00	3.113+00	2.991+10	1.124+10	4.035+05	1.675+05
40	1.440+10	8.675-01	1.095+11	1.214+03	1.572+00	3.124+00	3.065+10	1.153+10	4.067+05	1.697+05
41	1.476+10	8.663-01	1.117+11	1.235+03	1.576+00	3.135+00	3.139+10	1.183+10	4.099+05	1.718+05
42	1.512+10	8.651-01	1.139+11	1.256+03	1.580+00	3.146+00	3.213+10	1.212+10	4.130+05	1.739+05
43	1.548+10	8.639-01	1.161+11	1.277+03	1.584+00	3.157+00	3.286+10	1.241+10	4.161+05	1.759+05
44	1.584+10	8.628-01	1.183+11	1.299+03	1.588+00	3.168+00	3.360+10	1.271+10	4.191+05	1.780+05
45	1.620+10	8.616-01	1.205+11	1.320+03	1.592+00	3.179+00	3.434+10	1.300+10	4.221+05	1.800+05
46	1.656+10	8.605-01	1.227+11	1.341+03	1.595+00	3.189+00	3.508+10	1.329+10	4.250+05	1.820+05
47	1.692+10	8.595-01	1.248+11	1.363+03	1.599+00	3.200+00	3.581+10	1.359+10	4.279+05	1.840+05
48	1.728+10	8.584-01	1.270+11	1.384+03	1.602+00	3.210+00	3.655+10	1.388+10	4.308+05	1.859+05
49	1.764+10	8.573-01	1.292+11	1.405+03	1.606+00	3.221+00	3.729+10	1.417+10	4.336+05	1.879+06

TABLE B.5 (Continued)

15 Percent Water, 20 Percent Porosity Mixture (Continued)

50	1.800+10	3.563-01	1.313+11	1.426+03	1.609+00	3.231+00	3.803+10	1.447+10	4.363+05	1.898+05
51	1.836+10	3.553-01	1.335+11	1.448+03	1.612+00	3.241+00	3.876+10	1.476+10	4.391+05	1.917+05
52	1.872+10	3.543-01	1.356+11	1.469+03	1.616+00	3.251+00	3.950+10	1.505+10	4.418+05	1.935+05
53	1.908+10	3.533-01	1.377+11	1.490+03	1.619+00	3.261+00	4.024+10	1.535+10	4.444+05	1.954+05
54	1.944+10	3.524-01	1.398+11	1.512+03	1.622+00	3.270+00	4.097+10	1.564+10	4.471+05	1.972+05
55	1.980+10	3.514-01	1.419+11	1.533+03	1.625+00	3.280+00	4.171+10	1.593+10	4.497+05	1.990+05
56	2.016+10	3.505-01	1.441+11	1.554+03	1.629+00	3.290+00	4.245+10	1.623+10	4.522+05	2.009+05
57	2.052+10	3.496-01	1.462+11	1.575+03	1.632+00	3.299+00	4.319+10	1.652+10	4.548+05	2.026+05
58	2.088+10	3.487-01	1.482+11	1.597+03	1.635+00	3.308+00	4.393+10	1.681+10	4.573+05	2.044+05
59	2.124+10	3.478-01	1.503+11	1.618+03	1.638+00	3.318+00	4.466+10	1.711+10	4.598+05	2.062+05
60	2.160+10	3.469-01	1.524+11	1.639+03	1.641+00	3.327+00	4.540+10	1.740+10	4.622+05	2.079+05
61	2.196+10	3.460-01	1.545+11	1.661+03	1.644+00	3.336+00	4.614+10	1.769+10	4.646+05	2.097+05
62	2.232+10	3.452-01	1.566+11	1.682+03	1.647+00	3.345+00	4.688+10	1.799+10	4.670+05	2.114+05
63	2.268+10	3.443-01	1.586+11	1.703+03	1.650+00	3.354+00	4.762+10	1.828+10	4.694+05	2.131+05
64	2.304+10	3.435-01	1.607+11	1.725+03	1.652+00	3.363+00	4.836+10	1.857+10	4.718+05	2.148+05
65	2.340+10	3.427-01	1.627+11	1.746+03	1.655+00	3.372+00	4.910+10	1.886+10	4.741+05	2.164+05
66	2.376+10	3.419-01	1.648+11	1.767+03	1.658+00	3.381+00	4.984+10	1.916+10	4.764+05	2.181+05
67	2.412+10	3.412-01	1.664+11	1.791+03	1.663+00	3.387+00	5.068+10	1.943+10	4.782+05	2.194+05
68	2.448+10	3.404-01	1.684+11	1.813+03	1.665+00	3.395+00	5.142+10	1.973+10	4.804+05	2.210+05
69	2.484+10	3.397-01	1.705+11	1.834+03	1.667+00	3.404+00	5.216+10	2.002+10	4.827+05	2.227+05
70	2.520+10	3.389-01	1.725+11	1.855+03	1.670+00	3.412+00	5.290+10	2.031+10	4.849+05	2.243+05
71	2.556+10	3.381-01	1.745+11	1.877+03	1.673+00	3.421+00	5.364+10	2.060+10	4.871+05	2.259+05
72	2.592+10	3.374-01	1.765+11	1.898+03	1.676+00	3.429+00	5.439+10	2.090+10	4.892+05	2.275+05
73	2.628+10	3.367-01	1.785+11	1.920+03	1.678+00	3.437+00	5.513+10	2.119+10	4.914+05	2.290+05
74	2.664+10	3.359-01	1.806+11	1.941+03	1.681+00	3.446+00	5.587+10	2.148+10	4.936+05	2.307+05
75	2.700+10	3.352-01	1.826+11	1.962+03	1.683+00	3.454+00	5.660+10	2.178+10	4.957+05	2.322+05
76	2.736+10	3.345-01	1.846+11	1.984+03	1.686+00	3.462+00	5.735+10	2.207+10	4.978+05	2.338+05
77	2.772+10	3.338-01	1.865+11	2.006+03	1.688+00	3.470+00	5.810+10	2.236+10	4.999+05	2.353+05
78	2.808+10	3.342-01	1.895+11	2.030+03	1.668+00	3.480+00	5.858+10	2.270+10	5.041+05	2.370+05
79	2.844+10	3.336-01	1.915+11	2.052+03	1.669+00	3.488+00	5.929+10	2.300+10	5.064+05	2.385+05
80	2.880+10	3.329-01	1.935+11	2.073+03	1.670+00	3.496+00	6.003+10	2.329+10	5.085+05	2.400+05
81	2.916+10	3.323-01	1.955+11	2.095+03	1.672+00	3.504+00	6.076+10	2.358+10	5.105+05	2.415+05
82	2.952+10	3.315-01	1.977+11	2.115+03	1.675+00	3.513+00	6.147+10	2.388+10	5.127+05	2.432+05
83	2.988+10	3.309-01	1.996+11	2.137+03	1.678+00	3.520+00	6.223+10	2.417+10	5.146+05	2.446+05
84	3.024+10	3.302-01	2.016+11	2.159+03	1.680+00	3.528+00	6.297+10	2.446+10	5.166+05	2.461+05
85	3.060+10	3.296-01	2.036+11	2.181+03	1.682+00	3.536+00	6.371+10	2.476+10	5.186+05	2.475+05
86	3.096+10	3.290-01	2.056+11	2.202+03	1.683+00	3.543+00	6.445+10	2.505+10	5.206+05	2.490+05
87	3.132+10	3.284-01	2.075+11	2.224+03	1.685+00	3.551+00	6.518+10	2.534+10	5.226+05	2.504+05
88	3.168+10	3.278-01	2.095+11	2.246+03	1.687+00	3.558+00	6.592+10	2.564+10	5.245+05	2.519+05
89	3.204+10	3.272-01	2.115+11	2.267+03	1.689+00	3.566+00	6.666+10	2.593+10	5.265+05	2.533+05
90	3.240+10	3.266-01	2.135+11	2.289+03	1.690+00	3.573+00	6.740+10	2.622+10	5.284+05	2.547+05
91	3.276+10	3.260-01	2.154+11	2.311+03	1.692+00	3.581+00	6.813+10	2.652+10	5.303+05	2.561+05
92	3.312+10	3.254-01	2.174+11	2.333+03	1.694+00	3.588+00	6.887+10	2.681+10	5.322+05	2.575+05
93	3.348+10	3.249-01	2.193+11	2.354+03	1.695+00	3.596+00	6.961+10	2.710+10	5.341+05	2.589+05
94	3.384+10	3.243-01	2.213+11	2.376+03	1.697+00	3.603+00	7.035+10	2.740+10	5.360+05	2.603+05
95	3.420+10	3.238-01	2.233+11	2.398+03	1.699+00	3.610+00	7.109+10	2.769+10	5.379+05	2.617+05
96	3.456+10	3.232-01	2.252+11	2.420+03	1.700+00	3.617+00	7.183+10	2.798+10	5.397+05	2.631+05
97	3.492+10	3.227-01	2.271+11	2.441+03	1.702+00	3.625+00	7.257+10	2.828+10	5.416+05	2.645+05
98	3.528+10	3.221-01	2.291+11	2.463+03	1.703+00	3.632+00	7.330+10	2.857+10	5.434+05	2.658+05
99	3.564+10	3.216-01	2.310+11	2.485+03	1.705+00	3.639+00	7.404+10	2.886+10	5.452+05	2.672+05
100	3.600+10	3.210-01	2.330+11	2.507+03	1.707+00	3.646+00	7.478+10	2.916+10	5.471+05	2.685+05

TABLE B.5 (Continued)

15 Percent Water, 20 Percent Porosity Mixture (Continued)

101	3.636+10	3.205-01	2.349+11	2.529+03	1.708+00	3.653+00	7.552+10	2.945+10	5.489+05	2.699+05
102	3.672+10	3.200-01	2.368+11	2.550+03	1.710+00	3.660+00	7.626+10	2.974+10	5.506+05	2.712+05
103	3.708+10	3.195-01	2.388+11	2.572+03	1.711+00	3.667+00	7.700+10	3.003+10	5.524+05	2.725+05
104	3.744+10	3.190-01	2.407+11	2.594+03	[illegible]	3.674+00	7.775+10	3.033+10	5.542+05	2.739+05
105	3.780+10	3.185-01	2.426+11	2.616+03	1.714+00	3.681+00	7.849+10	3.062+10	5.560+05	2.752+05
106	3.816+10	3.179-01	[illegible]	2.638+03	1.715+00	3.687+00	7.923+10	3.091+10	5.577+05	2.765+05
107	3.852+10	3.175-01	2.465+11	2.660+03	1.717+00	3.694+00	7.997+10	3.121+10	5.594+05	2.778+05
108	3.888+10	3.170-01	2.484+11	2.682+03	1.718+00	3.701+00	8.071+10	3.150+10	5.612+05	2.791+05
109	3.924+10	3.165-01	2.503+11	2.704+03	1.720+00	3.708+00	8.145+10	3.179+10	5.629+05	2.804+05
110	3.960+10	3.160-01	2.522+11	2.726+03	1.721+00	3.715+00	8.219+10	3.208+10	5.646+05	2.817+05
111	3.996+10	3.160-01	2.528+11	2.755+03	1.720+00	3.715+00	8.314+10	3.234+10	5.653+05	2.820+05
112	4.032+10	3.151-01	2.565+11	2.768+03	1.719+00	3.730+00	8.352+10	3.270+10	5.686+05	2.844+05
113	4.068+10	3.145-01	2.582+11	2.790+03	1.724+00	3.736+00	8.436+10	3.297+10	5.700+05	2.857+05
114	4.104+10	3.145-01	2.585+11	2.821+03	1.725+00	3.735+00	8.538+10	3.321+10	5.703+05	2.858+05
115	4.140+10	3.137-01	2.621+11	2.834+03	1.723+00	3.750+00	8.577+10	3.357+10	5.736+05	2.882+05
116	4.176+10	3.131-01	2.639+11	2.856+03	1.728+00	3.756+00	8.659+10	3.385+10	5.750+05	2.894+05
117	4.212+10	3.131-01	2.642+11	2.887+03	1.730+00	3.754+00	8.762+10	3.409+10	5.752+05	2.896+05
118	4.248+10	3.123-01	2.678+11	2.900+03	1.727+00	3.769+00	8.800+10	3.445+10	5.785+05	2.919+05
119	4.284+10	3.118-01	2.696+11	2.922+03	1.732+00	3.775+00	8.881+10	3.473+10	5.799+05	2.932+05
120	4.320+10	3.118-01	2.698+11	2.953+03	1.734+00	3.774+00	8.986+10	3.497+10	5.801+05	2.933+05
121	4.356+10	3.110-01	2.735+11	2.966+03	1.731+00	3.789+00	9.023+10	3.532+10	5.834+05	2.956+05
122	4.392+10	3.104-01	2.753+11	2.988+03	1.736+00	3.794+00	9.104+10	3.560+10	5.848+05	2.969+05
123	4.428+10	3.104-01	2.755+11	3.019+03	1.738+00	3.793+00	9.211+10	3.584+10	5.849+05	2.970+05
124	4.464+10	3.097-01	2.792+11	3.032+03	1.735+00	3.808+00	9.246+10	3.620+10	5.882+05	2.993+05
125	4.500+10	3.091-01	2.810+11	3.054+03	1.739+00	3.813+00	9.328+10	3.648+10	5.896+05	3.005+05
126	4.536+10	3.091-01	2.811+11	3.086+03	1.742+00	3.811+00	9.435+10	3.671+10	5.897+05	3.006+05
127	4.572+10	3.084-01	2.848+11	3.098+03	1.738+00	3.826+00	9.470+10	3.708+10	5.929+05	3.029+05
128	4.608+10	3.079-01	2.866+11	3.120+03	1.743+00	3.832+00	9.551+10	3.736+10	5.943+05	3.041+05
129	4.644+10	3.079-01	2.867+11	3.152+03	1.745+00	3.830+00	9.660+10	3.759+10	5.944+05	3.042+05
130	4.680+10	3.072-01	2.904+11	3.165+03	1.752+00	3.845+00	9.694+10	3.795+10	5.976+05	3.065+05
131	4.716+10	3.066-01	2.923+11	3.187+03	1.746+00	3.850+00	9.775+10	3.823+10	5.990+05	3.077+05
132	4.752+10	3.066-01	2.923+11	3.219+03	1.749+00	3.848+00	9.885+10	3.846+10	5.990+05	3.077+05
133	4.788+10	3.060-01	2.960+11	3.231+03	1.745+00	3.863+00	9.918+10	3.883+10	6.022+05	3.100+05
134	4.824+10	3.054-01	2.979+11	3.253+03	1.750+00	3.869+00	9.998+10	3.911+10	6.036+05	3.112+05
135	4.860+10	3.054-01	2.978+11	3.285+03	1.753+00	3.866+00	1.011+11	3.933+10	6.035+05	3.112+05
136	4.896+10	3.048-01	3.016+11	3.298+03	1.749+00	3.871+00	1.014+11	3.970+10	6.067+05	3.135+05

TABLE B.5 (Continued)

15 PERCENT WATER, 15 PERCENT POROSITY MIXTURE

K	AIR	TVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	4.752-01	6.082+09	3.297+02	1.163+00	2.455+00	6.115+08	3.156+08	1.346+05	2.682+04
2	7.200+08	4.626-01	1.100+10	3.580+02	1.226+00	2.498+00	1.421+09	5.962+08	1.720+05	3.794+04
3	1.080+09	4.533-01	1.542+10	3.841+02	1.270+00	2.535+00	2.234+09	8.764+08	1.968+05	4.647+04
4	1.440+09	4.460-01	1.952+10	4.088+02	1.304+00	2.569+00	3.038+09	1.158+09	2.159+05	5.366+04
5	1.800+09	4.397-01	2.341+10	4.325+02	1.331+00	2.599+00	3.833+09	1.441+09	2.316+05	5.999+04
6	2.160+09	4.342-01	2.712+10	4.555+02	1.354+00	2.628+00	4.619+09	1.726+09	2.449+05	6.572+04
7	2.520+09	4.293-01	3.070+10	4.781+02	1.375+00	2.654+00	5.397+09	2.012+09	2.567+05	7.098+04
8	2.880+09	4.251-01	3.405+10	5.004+02	1.392+00	2.679+00	6.174+09	2.299+09	2.669+05	7.571+04
9	3.240+09	4.210-01	3.740+10	5.223+02	1.408+00	2.703+00	6.940+09	2.587+09	2.764+05	8.031+04
10	3.600+09	4.173-01	4.069+10	5.437+02	1.423+00	2.726+00	7.699+09	2.877+09	2.852+05	8.467+04
11	3.960+09	4.137-01	4.389+10	5.650+02	1.437+00	2.746+00	8.454+09	3.167+09	2.933+05	8.882+04
12	4.320+09	4.104-01	4.704+10	5.861+02	1.450+00	2.769+00	9.205+09	3.458+09	3.009+05	9.278+04
13	4.680+09	4.073-01	5.012+10	6.070+02	1.462+00	2.789+00	9.952+09	3.750+09	3.080+05	9.659+04
14	5.040+09	4.044-01	5.315+10	6.277+02	1.473+00	2.809+00	1.070+10	4.042+09	3.147+05	1.002+05
15	5.400+09	4.016-01	5.614+10	6.483+02	1.484+00	2.828+00	1.144+10	4.335+09	3.210+05	1.038+05
16	5.760+09	3.990-01	5.908+10	6.688+02	1.494+00	2.847+00	1.218+10	4.628+09	3.271+05	1.072+05
17	6.120+09	3.964-01	6.198+10	6.893+02	1.504+00	2.865+00	1.291+10	4.921+09	3.328+05	1.105+05
18	6.480+09	3.940-01	6.484+10	7.096+02	1.513+00	2.883+00	1.365+10	5.215+09	3.384+05	1.137+05
19	6.840+09	3.917-01	6.766+10	7.299+02	1.522+00	2.900+00	1.438+10	5.510+09	3.437+05	1.168+05
20	7.200+09	3.895-01	7.046+10	7.501+02	1.530+00	2.917+00	1.511+10	5.804+09	3.488+05	1.199+05
21	7.560+09	3.873-01	7.322+10	7.703+02	1.538+00	2.933+00	1.584+10	6.099+09	3.537+05	1.229+05
22	7.920+09	3.853-01	7.596+10	7.904+02	1.546+00	2.949+00	1.657+10	6.394+09	3.585+05	1.258+05
23	8.280+09	3.833-01	7.867+10	8.104+02	1.554+00	2.965+00	1.730+10	6.689+09	3.631+05	1.286+05
24	8.640+09	3.813-01	8.135+10	8.305+02	1.561+00	2.980+00	1.802+10	6.984+09	3.675+05	1.314+05
25	9.000+09	3.795-01	8.401+10	8.505+02	1.568+00	2.995+00	1.875+10	7.280+09	3.719+05	1.341+05
26	9.360+09	3.777-01	8.665+10	8.705+02	1.575+00	3.010+00	1.947+10	7.575+09	3.761+05	1.367+05
27	9.720+09	3.759-01	8.927+10	8.904+02	1.581+00	3.024+00	2.020+10	7.871+09	3.802+05	1.394+05
28	1.008+10	3.742-01	9.187+10	9.104+02	1.588+00	3.038+00	2.092+10	8.167+09	3.842+05	1.419+05
29	1.044+10	3.726-01	9.444+10	9.303+02	1.594+00	3.052+00	2.164+10	8.463+09	3.880+05	1.444+05
30	1.080+10	3.710-01	9.700+10	9.502+02	1.600+00	3.066+00	2.237+10	8.759+09	3.918+05	1.469+05
31	1.116+10	3.694-01	9.954+10	9.701+02	1.606+00	3.080+00	2.309+10	9.055+09	3.956+05	1.493+05
32	1.152+10	3.679-01	1.021+11	9.900+02	1.612+00	3.093+00	2.381+10	9.351+09	3.992+05	1.517+05
33	1.188+10	3.664-01	1.046+11	1.010+03	1.618+00	3.106+00	2.453+10	9.647+09	4.027+05	1.541+05
34	1.224+10	3.649-01	1.071+11	1.030+03	1.623+00	3.119+00	2.526+10	9.943+09	4.062+05	1.564+05
35	1.260+10	3.635-01	1.096+11	1.050+03	1.629+00	3.132+00	2.598+10	1.024+10	4.096+05	1.587+05
36	1.296+10	3.621-01	1.120+11	1.070+03	1.634+00	3.144+00	2.670+10	1.054+10	4.130+05	1.610+05
37	1.332+10	3.608-01	1.145+11	1.089+03	1.639+00	3.157+00	2.742+10	1.083+10	4.163+05	1.632+05
38	1.368+10	3.595-01	1.169+11	1.109+03	1.644+00	3.169+00	2.814+10	1.113+10	4.195+05	1.654+05
39	1.404+10	3.582-01	1.193+11	1.129+03	1.649+00	3.181+00	2.887+10	1.142+10	4.227+05	1.676+05
40	1.440+10	3.569-01	1.217+11	1.149+03	1.654+00	3.193+00	2.959+10	1.172+10	4.258+05	1.697+05
41	1.476+10	3.557-01	1.242+11	1.169+03	1.659+00	3.205+00	3.031+10	1.202+10	4.288+05	1.718+05
42	1.512+10	3.545-01	1.265+11	1.189+03	1.663+00	3.216+00	3.103+10	1.231+10	4.318+05	1.739+05
43	1.548+10	3.533-01	1.289+11	1.209+03	1.668+00	3.228+00	3.175+10	1.261+10	4.348+05	1.760+05
44	1.584+10	3.521-01	1.313+11	1.229+03	1.673+00	3.239+00	3.248+10	1.290+10	4.377+05	1.780+05
45	1.620+10	3.510-01	1.337+11	1.249+03	1.677+00	3.250+00	3.320+10	1.320+10	4.406+05	1.800+05
46	1.656+10	3.499-01	1.360+11	1.269+03	1.681+00	3.261+00	3.392+10	1.350+10	4.434+05	1.820+05
47	1.692+10	3.488-01	1.383+11	1.289+03	1.686+00	3.272+00	3.464+10	1.379+10	4.462+05	1.840+05
48	1.728+10	3.477-01	1.407+11	1.308+03	1.690+00	3.283+00	3.537+10	1.409+10	4.490+05	1.859+05
49	1.764+10	3.466-01	1.430+11	1.328+03	1.694+00	3.294+00	3.609+10	1.438+10	4.517+05	1.879+05

TABLE B.5 (Continued)

15 Percent Water, 15 Percent Porosity Mixture (Continued)

50	1.800+10	3.456-01	1.453+11	1.348+03	1.698+00	3.304+00	3.681+10	1.468+10	4.544+05	1.898+05
51	1.836+10	3.446-01	1.476+11	1.368+03	1.702+00	3.315+00	3.754+10	1.498+10	4.570+05	1.917+05
52	1.872+10	3.436-01	1.499+11	1.388+03	1.706+00	3.325+00	3.826+10	1.527+10	4.596+05	1.935+05
53	1.908+10	3.426-01	1.522+11	1.408+03	1.710+00	3.335+00	3.899+10	1.557+10	4.622+05	1.954+05
54	1.944+10	3.416-01	1.545+11	1.428+03	1.714+00	3.345+00	3.971+10	1.586+10	4.647+05	1.972+05
55	1.980+10	3.406-01	1.567+11	1.448+03	1.718+00	3.355+00	4.044+10	1.616+10	4.673+05	1.991+05
56	2.016+10	3.397-01	1.590+11	1.468+03	1.722+00	3.365+00	4.116+10	1.645+10	4.698+05	2.009+05
57	2.052+10	3.388-01	1.613+11	1.488+03	1.726+00	3.375+00	4.189+10	1.675+10	4.722+05	2.027+05
58	2.088+10	3.378-01	1.635+11	1.509+03	1.729+00	3.385+00	4.261+10	1.704+10	4.746+05	2.044+05
59	2.124+10	3.369-01	1.657+11	1.529+03	1.733+00	3.395+00	4.334+10	1.734+10	4.770+05	2.062+05
60	2.160+10	3.361-01	1.680+11	1.549+03	1.736+00	3.404+00	4.407+10	1.764+10	4.794+05	2.079+05
61	2.196+10	3.352-01	1.702+11	1.569+03	1.740+00	3.414+00	4.479+10	1.793+10	4.818+05	2.097+05
62	2.232+10	3.343-01	1.724+11	1.589+03	1.744+00	3.423+00	4.552+10	1.823+10	4.841+05	2.114+05
63	2.268+10	3.335-01	1.746+11	1.609+03	1.747+00	3.433+00	4.625+10	1.852+10	4.864+05	2.131+05
64	2.304+10	3.326-01	1.769+11	1.629+03	1.750+00	3.442+00	4.698+10	1.882+10	4.887+05	2.148+05
65	2.340+10	3.318-01	1.791+11	1.649+03	1.754+00	3.451+00	4.770+10	1.911+10	4.910+05	2.164+05
66	2.376+10	3.310-01	1.813+11	1.669+03	1.757+00	3.460+00	4.843+10	1.941+10	4.932+05	2.181+05
67	2.412+10	3.302-01	1.834+11	1.690+03	1.761+00	3.469+00	4.916+10	1.970+10	4.954+05	2.198+05
68	2.448+10	3.294-01	1.856+11	1.710+03	1.764+00	3.478+00	4.989+10	2.000+10	4.976+05	2.214+05
69	2.484+10	3.286-01	1.878+11	1.730+03	1.767+00	3.487+00	5.062+10	2.029+10	4.998+05	2.230+05
70	2.520+10	3.279-01	1.900+11	1.750+03	1.770+00	3.496+00	5.135+10	2.059+10	5.019+05	2.246+05
71	2.556+10	3.271-01	1.922+11	1.771+03	1.773+00	3.505+00	5.208+10	2.088+10	5.041+05	2.262+05
72	2.592+10	3.264-01	1.943+11	1.791+03	1.777+00	3.514+00	5.281+10	2.117+10	5.062+05	2.278+05
73	2.628+10	3.256-01	1.965+11	1.811+03	1.780+00	3.522+00	5.354+10	2.147+10	5.083+05	2.294+05
74	2.664+10	3.249-01	1.986+11	1.831+03	1.783+00	3.531+00	5.428+10	2.176+10	5.104+05	2.310+05
75	2.700+10	3.242-01	2.007+11	1.852+03	1.786+00	3.539+00	5.501+10	2.206+10	5.124+05	2.325+05
76	2.736+10	3.234-01	2.029+11	1.872+03	1.789+00	3.548+00	[illegible]	2.235+10	5.145+05	2.341+05
77	2.772+10	3.227-01	2.051+11	1.892+03	1.792+00	3.556+00	5.647+10	2.265+10	5.165+05	2.356+05
78	2.808+10	3.220-01	2.072+11	1.913+03	1.795+00	3.565+00	5.721+10	2.294+10	5.185+05	2.371+05
79	2.844+10	3.213-01	2.093+11	1.933+03	1.798+00	3.573+00	5.794+10	2.323+10	5.205+05	2.387+05
80	2.880+10	3.207-01	2.115+11	1.953+03	1.801+00	3.581+00	5.868+10	2.353+10	5.225+05	2.402+05
81	2.916+10	3.200-01	2.136+11	1.974+03	1.803+00	3.589+00	5.941+10	2.382+10	5.245+05	2.417+05
82	2.952+10	3.200-01	2.168+11	1.997+03	1.789+00	3.600+00	5.981+10	2.417+10	[illegible]	2.435+05
83	2.988+10	3.200-01	2.180+11	2.024+03	1.783+00	3.609+00	6.058+10	2.446+10	5.298+05	2.442+05
84	3.024+10	3.186-01	2.208+11	2.038+03	1.798+00	3.614+00	6.138+10	2.474+10	5.319+05	2.464+05
85	3.060+10	3.186-01	2.220+11	2.066+03	1.793+00	3.618+00	6.215+10	2.503+10	5.333+05	2.470+05
86	3.096+10	3.173-01	2.251+11	2.079+03	1.803+00	3.635+00	6.284+10	2.533+10	5.358+05	2.493+05
87	3.132+10	3.173-01	2.262+11	2.106+03	1.798+00	3.634+00	6.360+10	2.562+10	5.372+05	2.499+05
88	[illegible]	3.166-01	2.290+11	2.124+03	1.799+00	3.645+00	6.420+10	2.594+10	5.397+05	2.518+05
89	3.204+10	3.159-01	2.311+11	2.144+03	1.803+00	3.653+00	6.496+10	2.623+10	5.415+05	2.532+05
90	3.240+10	3.153-01	2.331+11	2.165+03	1.805+00	3.660+00	6.571+10	2.652+10	5.433+05	2.546+05
91	3.276+10	3.147-01	2.352+11	2.186+03	1.808+00	3.668+00	6.644+10	2.682+10	5.451+05	2.560+05
92	3.312+10	3.141-01	2.373+11	2.207+03	1.810+00	3.676+00	6.717+10	2.711+10	5.470+05	2.574+05
93	3.348+10	3.136-01	2.394+11	2.227+03	1.812+00	3.683+00	6.790+10	2.741+10	5.488+05	2.588+05
94	3.384+10	3.130-01	2.414+11	2.248+03	1.815+00	3.691+00	6.863+10	2.770+10	5.506+05	2.602+05
95	3.420+10	3.124-01	2.435+11	2.269+03	1.817+00	3.698+00	6.937+10	2.799+10	5.524+05	2.616+05
96	3.456+10	3.118-01	2.456+11	2.290+03	1.819+00	3.706+00	7.010+10	2.829+10	5.542+05	2.630+05
97	3.492+10	3.113-01	2.477+11	2.310+03	1.821+00	3.713+00	7.083+10	2.858+10	5.560+05	2.644+05
98	3.528+10	3.107-01	2.497+11	2.331+03	1.823+00	3.720+00	7.157+10	2.888+10	5.578+05	2.657+05
99	3.564+10	3.102-01	2.518+11	2.352+03	1.826+00	3.728+00	7.230+10	2.917+10	5.595+05	2.671+05
100	3.600+10	3.096-01	2.542+11	2.371+03	1.826+00	3.737+00	7.299+10	2.948+10	5.616+05	2.686+05
101	3.636+10	3.091-01	2.563+11	2.392+03	1.828+00	3.744+00	7.367+10	2.978+10	5.634+05	2.700+05
102	3.672+10	3.085-01	2.583+11	2.413+03	1.831+00	3.751+00	7.442+10	3.007+10	5.651+05	2.713+05
103	3.708+10	3.080-01	2.604+11	2.434+03	1.833+00	3.758+00	7.515+10	3.036+10	5.668+05	2.726+05

TABLE B.5 (Continued)

15 Percent Water, 15 Percent Porosity Mixture (Continued)

104	3.744+10	3.075-01	2.624+11	2.454+03	1.835+00	3.766+00	7.589+10	3.066+10	5.685+05	2.739+05
105	3.780+10	3.070-01	2.645+11	2.475+03	1.837+00	3.773+00	7.662+10	3.095+10	5.702+05	2.753+05
106	3.816+10	3.065-01	2.665+11	2.496+03	1.839+00	3.780+00	7.736+10	3.124+10	5.719+05	2.766+05
107	3.852+10	3.059-01	2.686+11	2.517+03	1.841+00	3.787+00	7.809+10	3.154+10	5.736+05	2.779+05
108	3.888+10	3.054-01	2.706+11	2.538+03	1.843+00	3.794+00	7.883+10	3.183+10	5.752+05	2.792+05
109	3.924+10	3.049-01	2.726+11	2.559+03	1.845+00	3.801+00	7.956+10	3.212+10	5.769+05	2.805+05
110	3.960+10	3.045-01	2.747+11	2.580+03	1.847+00	3.808+00	8.030+10	3.242+10	5.786+05	2.817+05
111	3.996+10	3.040-01	2.767+11	2.601+03	1.849+00	3.815+00	8.104+10	3.271+10	5.802+05	2.830+05
112	4.032+10	3.035-01	2.787+11	2.622+03	1.851+00	3.822+00	8.177+10	3.300+10	5.818+05	2.843+05
113	4.068+10	3.030-01	2.808+11	2.643+03	1.853+00	3.828+00	8.251+10	3.330+10	5.835+05	2.856+05
114	4.104+10	3.025-01	2.828+11	2.664+03	1.854+00	3.835+00	8.325+10	3.359+10	5.851+05	2.868+05
115	4.140+10	3.020-01	2.848+11	2.685+03	1.856+00	3.842+00	8.399+10	3.388+10	5.867+05	2.881+05
116	4.176+10	3.016-01	2.868+11	2.706+03	1.858+00	3.849+00	8.473+10	3.418+10	5.883+05	2.893+05
117	4.212+10	3.011-01	2.888+11	2.727+03	1.860+00	3.855+00	8.547+10	3.447+10	5.899+05	2.906+05
118	4.248+10	3.006-01	2.909+11	2.748+03	1.862+00	3.862+00	8.621+10	3.476+10	5.915+05	2.918+05
119	4.284+10	3.002-01	2.929+11	2.769+03	1.864+00	3.869+00	8.695+10	3.506+10	5.930+05	2.931+05
120	4.320+10	2.997-01	2.949+11	2.790+03	1.866+00	3.875+00	8.769+10	3.535+10	5.946+05	2.943+05
121	4.356+10	2.993-01	2.969+11	2.811+03	1.867+00	3.882+00	8.843+10	3.564+10	5.962+05	2.955+05
122	4.392+10	2.988-01	2.989+11	2.832+03	1.869+00	3.888+00	8.917+10	3.593+10	5.977+05	2.967+05
123	4.428+10	2.984-01	3.009+11	2.854+03	1.871+00	3.895+00	8.991+10	3.623+10	5.993+05	2.980+05

TABLE B.5 (Continued)

15 PERCENT WATER, 10 PERCENT POROSITY MIXTURE

K	AIR	TVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	4.693-01	7.889+09	3.296+02	1.196+00	2.472+00	5.411+08	3.280+08	1.648+05	2.683+04
2	7.200+08	4.557-01	1.372+10	3.558+02	1.264+00	2.522+00	1.313+09	6.153+08	2.028+05	3.792+04
3	1.080+09	4.460-01	1.878+10	3.795+02	1.310+00	2.564+00	2.087+09	9.023+08	2.270+05	4.638+04
4	1.440+09	4.380-01	2.352+10	4.017+02	1.347+00	2.602+00	2.849+09	1.192+09	2.456+05	5.366+04
5	1.800+09	4.315-01	2.790+10	4.230+02	1.377+00	2.636+00	3.604+09	1.482+09	2.606+05	5.999+04
6	2.160+09	4.258-01	3.205+10	4.437+02	1.402+00	2.667+00	4.352+09	1.773+09	2.734+05	6.571+04
7	2.520+09	4.207-01	3.603+10	4.638+02	1.424+00	2.696+00	5.093+09	2.066+09	2.845+05	7.098+04
8	2.880+09	4.161-01	3.986+10	4.836+02	1.444+00	2.723+00	5.830+09	2.359+09	2.945+05	7.587+0[illegible]
9	3.240+09	4.120-01	4.345+10	5.035+02	1.460+00	2.748+00	6.567+09	2.653+09	3.032+05	8.031+04
10	3.600+09	4.082-01	4.705+10	5.229+02	1.477+00	2.772+00	7.295+09	2.948+09	3.115+05	8.466+04
11	3.960+09	4.045-01	5.057+10	5.419+02	1.492+00	2.796+00	8.018+09	3.244+09	3.192+05	8.881+04
12	4.320+09	4.012-01	5.402+10	5.609+02	1.506+00	2.819+00	8.738+09	3.540+09	3.264+05	9.277+04
13	4.680+09	3.980-01	5.739+10	5.797+02	1.520+00	2.840+00	9.456+09	3.837+09	3.331+05	9.658+04
14	5.040+09	3.950-01	6.070+10	5.983+02	1.532+00	2.861+00	1.017+10	4.134+09	3.394+05	1.002+05
15	5.400+09	3.921-01	6.396+10	6.169+02	1.544+00	2.882+00	1.089+10	4.432+09	3.455+05	1.038+05
16	5.760+09	3.89[illegible]-01	6.716+10	6.355+02	1.555+00	2.901+00	1.160+10	4.730+09	3.512+05	1.072+05
17	6.120+09	3.868-01	7.031+10	6.539+02	1.566+00	2.920+00	1.231+10	5.028+09	3.567+05	1.105+05
18	6.480+09	3.844-01	7.342+10	6.723+02	1.576+00	2.939+00	1.302+10	5.326+09	3.619+05	1.137+05
19	6.840+09	3.820-01	7.649+10	6.907+02	1.586+00	2.957+00	1.373+10	5.625+09	3.669+05	1.168+05
20	7.200+09	3.798-01	7.952+10	7.090+02	1.595+00	2.975+00	1.443+10	5.923+09	3.718+05	1.199+05
21	7.560+09	3.776-01	8.252+10	7.273+02	1.604+00	2.992+00	1.514+10	6.222+09	3.765+05	1.228+05
22	7.920+09	3.755-01	8.548+10	7.456+02	1.613+00	3.009+00	1.585+10	6.521+09	3.810+05	1.257+05
23	8.280+09	3.735-01	8.842+10	7.639+02	1.621+00	3.025+00	1.655+10	6.820+09	3.854+05	1.286+05
24	8.640+09	3.715-01	9.132+10	7.822+02	1.629+00	3.041+00	1.726+10	7.119+09	3.897+05	1.314+05
25	9.000+09	3.697-01	9.420+10	8.004+02	1.637+00	3.057+00	1.796+10	7.419+09	3.938+05	1.341+05
26	9.360+09	3.678-01	9.705+10	8.187+02	1.645+00	3.073+00	1.867+10	7.718+09	3.978+05	1.367+05
27	9.720+09	3.661-01	9.988+10	8.369+02	1.652+00	3.088+00	1.937+10	8.017+09	4.017+05	1.394+05
28	1.008+10	3.643-01	1.027+11	8.552+02	1.660+00	3.103+00	2.007+10	8.316+09	4.055+05	1.419+05
29	1.044+10	3.627-01	1.055+11	8.734+02	1.666+00	3.117+00	2.078+10	8.616+09	4.093+05	1.444+05
30	1.080+10	3.611-01	1.082+11	8.917+02	1.673+00	3.132+00	2.148+10	8.915+09	4.129+05	1.469+05
31	1.116+10	3.595-01	1.110+11	9.100+02	1.680+00	3.146+00	2.219+10	9.214+09	4.165+05	1.493+05
32	1.152+10	3.580-01	1.137+11	9.282+02	1.686+00	3.160+00	2.289+10	9.513+09	4.199+05	1.517+05
33	1.188+10	3.565-01	1.164+11	9.465+02	1.693+00	3.173+00	2.359+10	9.813+09	4.234+05	1.541+05
34	1.224+10	3.550-01	1.191+11	9.648+02	1.699+00	3.187+00	2.430+10	1.011+10	4.267+05	1.564+05
35	1.260+10	3.536-01	1.218+11	9.832+02	1.705+00	3.200+00	2.500+10	1.041+10	4.300+05	1.587+05
36	1.296+10	3.522-01	1.244+11	1.001+03	1.711+00	3.213+00	2.571+10	1.071+10	4.332+05	1.610+05
37	1.332+10	3.509-01	1.271+11	1.020+03	1.716+00	3.226+00	2.641+10	1.101+10	4.364+05	1.632+05
38	1.368+10	3.496-01	1.297+11	1.038+03	1.722+00	3.239+00	2.712+10	1.131+10	4.395+05	1.654+05
39	1.404+10	3.483-01	1.323+11	1.057+03	1.727+00	3.251+00	2.782+10	1.161+10	4.425+05	1.676+05
40	1.440+10	3.470-01	1.349+11	1.075+03	1.733+00	3.264+00	2.853+10	1.191+10	4.455+05	1.697+05
41	1.476+10	3.458-01	1.375+11	1.093+03	1.738+00	3.276+00	2.923+10	1.221+10	4.485+05	1.718+05
42	1.512+10	3.446-01	1.400+11	1.112+03	1.743+00	3.288+00	2.994+10	1.250+10	4.514+05	1.739+05
43	1.548+10	3.434-01	1.426+11	1.130+03	1.748+00	3.300+00	3.064+10	1.280+10	4.542+05	1.760+05
44	1.584+10	3.422-01	1.451+11	1.149+03	1.753+00	3.312+00	3.135+10	1.310+10	4.570+05	1.780+05
45	1.620+10	3.411-01	1.477+11	1.167+03	1.758+00	3.323+00	3.206+10	1.340+10	4.598+05	1.800+05
46	1.656+10	3.400-01	1.502+11	1.186+03	1.763+00	3.335+00	3.277+10	1.370+10	4.626+05	1.820+05
47	1.692+10	3.389-01	1.527+11	1.204+03	1.768+00	3.346+00	3.347+10	1.400+10	4.653+05	1.840+05
48	1.728+10	3.378-01	1.552+11	1.223+03	1.773+00	3.358+00	3.418+10	1.430+10	4.679+05	1.859+05
49	1.764+10	3.367-01	1.577+11	1.241+03	1.777+00	3.369+00	3.489+10	1.460+10	4.706+05	1.879+05
50	1.800+10	3.357-01	1.602+11	1.260+03	1.782+00	3.380+00	3.560+10	1.489+10	4.732+05	1.898+05
51	1.836+10	3.347-01	1.627+11	1.279+03	1.786+00	3.391+00	3.631+10	1.519+10	4.757+05	1.917+05
52	1.872+10	3.337-01	1.651+11	1.297+03	1.790+00	3.401+00	3.702+10	1.549+10	4.782+05	1.935+05

TABLE B.5 (Continued)

15 Percent Water, 10 Percent Porosity Mixture (Continued)

53	1.908+10	3.327-01	1.676+11	1.316+03	1.795+00	3.412+00	3.773+10	1.579+10	4.807+05	1.954+05
54	1.944+10	3.317-01	1.700+11	1.335+03	1.799+00	3.423+00	3.844+10	1.609+10	4.832+05	1.972+05
55	1.980+10	3.305-01	1.725+11	1.353+03	1.803+00	3.433+00	3.915+10	1.639+10	4.857+05	1.990+05
56	2.016+10	3.298-01	1.749+11	1.372+03	1.807+00	3.443+00	3.986+10	1.668+10	4.881+05	2.008+05
57	2.052+10	3.289-01	1.773+11	1.391+03	1.811+00	3.454+00	4.057+10	1.698+10	4.905+05	2.026+05
58	2.088+10	3.280-01	1.797+11	1.410+03	1.815+00	3.464+00	4.128+10	1.728+10	4.928+05	2.044+05
59	2.124+10	3.271-01	1.821+11	1.428+03	1.819+00	3.474+00	4.199+10	1.758+10	4.952+05	2.062+05
60	2.160+10	3.263-01	1.845+11	1.447+03	1.823+00	3.484+00	4.270+10	1.788+10	4.975+05	2.079+05
61	2.196+10	3.254-01	1.869+11	1.466+03	1.827+00	3.494+00	4.342+10	1.817+10	4.998+05	2.096+05
62	2.232+10	3.245-01	1.893+11	1.485+03	1.831+00	3.504+00	4.413+10	1.847+10	5.020+05	2.113+05
63	2.268+10	3.237-01	1.917+11	1.504+03	1.835+00	3.513+00	4.484+10	1.877+10	5.043+05	2.130+05
64	2.304+10	3.229-01	1.941+11	1.523+03	1.838+00	3.523+00	4.556+10	1.907+10	5.065+05	2.147+05
65	2.340+10	3.221-01	1.964+11	1.542+03	1.842+00	3.533+00	4.627+10	1.936+10	5.087+05	2.164+05
66	2.376+10	3.212-01	1.988+11	1.561+03	1.846+00	3.542+00	4.699+10	1.966+10	5.109+05	2.181+05
67	2.412+10	3.205-01	2.011+11	1.580+03	1.849+00	3.551+00	4.770+10	1.996+10	5.131+05	2.197+05
68	2.448+10	3.197-01	2.035+11	1.599+03	1.853+00	3.561+00	4.842+10	2.026+10	5.152+05	2.214+05
69	2.484+10	3.189-01	2.058+11	1.618+03	1.856+00	3.570+00	4.914+10	2.055+10	5.173+05	2.230+05
70	2.520+10	3.181-01	2.081+11	1.637+03	1.860+00	3.579+00	4.985+10	2.085+10	5.194+05	2.246+05
71	2.556+10	3.174-01	2.105+11	1.656+03	1.863+00	3.588+00	5.057+10	2.115+10	5.215+05	2.262+05
72	2.592+10	3.167-01	2.128+11	1.675+03	1.866+00	3.597+00	5.129+10	2.144+10	5.236+05	2.278+05
73	2.628+10	3.159-01	2.151+11	1.694+03	1.870+00	3.606+00	5.201+10	2.174+10	5.256+05	2.294+05
74	2.664+10	3.152-01	2.174+11	1.713+03	1.873+00	3.615+00	5.272+10	2.204+10	5.277+05	2.309+05
75	2.700+10	3.145-01	2.197+11	1.732+03	1.876+00	3.624+00	5.344+10	2.233+10	5.297+05	2.325+05
76	2.736+10	3.138-01	2.220+11	1.751+03	1.879+00	3.633+00	5.416+10	2.263+10	5.317+05	2.340+05
77	2.772+10	3.131-01	2.243+11	1.770+03	1.883+00	3.642+00	5.488+10	2.293+10	5.337+05	2.356+05
78	2.808+10	3.124-01	2.266+11	1.790+03	1.886+00	3.650+00	5.560+10	2.322+10	5.356+05	2.371+05
79	2.844+10	3.117-01	2.289+11	1.809+03	1.889+00	3.659+00	5.632+10	2.352+10	5.376+05	2.386+05
80	2.880+10	3.110-01	2.311+11	1.828+03	1.892+00	3.668+00	5.705+10	2.382+10	5.395+05	2.401+05
81	2.916+10	3.104-01	2.334+11	1.847+03	1.895+00	3.676+00	5.777+10	2.411+10	5.414+05	2.416+05
82	2.952+10	3.097-01	2.357+11	1.867+03	1.898+00	3.684+00	5.849+10	2.441+10	5.434+05	2.431+05
83	2.988+10	3.091-01	2.379+11	1.886+03	1.901+00	3.693+00	5.921+10	2.470+10	5.453+05	2.446+05
84	3.024+10	3.084-01	2.402+11	1.905+03	1.904+00	3.701+00	5.993+10	2.500+10	5.471+05	2.460+05
85	3.060+10	3.078-01	2.424+11	1.925+03	1.907+00	3.709+00	6.066+10	2.530+10	5.490+05	2.475+05
86	3.096+10	3.072-01	2.447+11	1.944+03	1.910+00	3.718+00	6.138+10	2.559+10	5.509+05	2.490+05
87	3.132+10	3.066-01	2.469+11	1.963+03	1.913+00	3.726+00	6.211+10	2.589+10	5.527+05	2.504+05
88	3.168+10	3.059-01	2.492+11	1.983+03	1.916+00	3.734+00	6.283+10	2.618+10	5.545+05	2.518+05
89	3.204+10	3.053-01	2.514+11	2.002+03	1.919+00	3.742+00	6.356+10	2.648+10	5.564+05	2.533+05
90	3.240+10	3.047-01	2.536+11	2.022+03	1.921+00	3.750+00	6.428+10	2.677+10	5.582+05	2.547+05
91	3.276+10	3.041-01	2.559+11	2.041+03	1.924+00	3.758+00	6.501+10	2.707+10	5.600+05	2.561+05
92	3.312+10	3.036-01	2.581+11	2.061+03	1.927+00	3.766+00	6.574+10	2.736+10	5.617+05	2.575+05
93	3.348+10	3.030-01	2.603+11	2.080+03	1.930+00	3.774+00	6.646+10	2.766+10	5.635+05	2.589+05
94	3.384+10	3.024-01	2.625+11	2.100+03	1.932+00	3.782+00	6.719+10	2.795+10	5.653+05	2.603+05
95	3.420+10	3.018-01	2.647+11	2.119+03	1.935+00	3.789+00	6.792+10	2.825+10	5.670+05	2.617+05
96	3.456+10	3.013-01	2.669+11	2.139+03	1.938+00	3.797+00	6.865+10	2.854+10	5.688+05	2.630+05
97	3.492+10	3.007-01	2.691+11	2.159+03	1.940+00	3.805+00	6.938+10	2.884+10	5.705+05	2.644+05
98	3.528+10	3.002-01	2.713+11	2.178+03	1.943+00	3.812+00	7.011+10	2.913+10	5.722+05	2.658+05
99	3.564+10	2.996-01	2.735+11	2.198+03	1.946+00	3.820+00	7.084+10	2.943+10	5.739+05	2.671+05
100	3.600+10	2.991-01	2.757+11	2.218+03	1.948+00	3.828+00	7.157+10	2.972+10	5.756+05	2.685+05
101	3.636+10	2.985-01	2.779+11	2.237+03	1.951+00	3.835+00	7.230+10	3.002+10	5.773+05	2.698+05
102	3.672+10	2.980-01	2.801+11	2.257+03	1.953+00	3.843+00	7.303+10	3.031+10	5.790+05	2.711+05
103	3.708+10	2.975-01	2.823+11	2.277+03	1.956+00	3.850+00	7.376+10	3.061+10	5.806+05	2.725+05

TABLE B.5 (Continued)

15 Percent Water, 10 Percent Porosity Mixture (Continued)

104	3.744+10	2.970-01	2.845+11	2.296+03	1.958+00	3.857+00	7.449+10	3.090+10	5.823+05	2.738+05
105	3.780+10	2.964-01	2.866+11	2.316+03	1.961+00	3.865+00	7.523+10	3.120+10	5.840+05	2.751+05
106	3.816+10	2.959-01	2.888+11	2.336+03	1.963+00	3.872+00	7.596+10	3.149+10	5.856+05	2.764+05
107	3.852+10	2.954-01	2.910+11	2.356+03	1.966+00	3.879+00	7.670+10	3.178+10	5.872+05	2.777+05
108	3.888+10	2.949-01	2.931+11	2.376+03	1.968+00	3.887+00	7.743+10	3.208+10	5.889+05	2.790+05
109	3.924+10	2.944-01	2.953+11	2.395+03	1.971+00	3.894+00	7.816+10	3.237+10	5.905+05	2.803+05
110	3.960+10	2.939-01	2.975+11	2.415+03	1.973+00	3.901+00	7.890+10	3.266+10	5.921+05	2.816+05
111	3.996+10	2.934-01	2.996+11	2.435+03	1.975+00	3.908+00	7.964+10	3.296+10	5.937+05	2.829+05
112	4.032+10	2.929-01	3.018+11	2.455+03	1.978+00	3.915+00	8.037+10	3.325+10	5.953+05	2.841+05

TABLE B.5 (Continued)

15 PERCENT WATER, 5 PERCENT POROSITY MIXTURE

K	AIX	TVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	4.621-01	1.044+10	3.285+02	1.236+00	2.495+00	4.465+08	3.447+08	2.067+05	2.683+04
2	7.200+08	4.474-01	1.715+10	3.516+02	1.312+00	2.552+00	1.177+09	6.394+08	2.406+05	3.785+04
3	1.080+09	4.375-01	2.304+10	3.720+02	1.357+00	2.600+00	1.895+09	9.362+08	2.636+05	4.642+04
4	1.440+09	4.293-01	2.833+10	3.910+02	1.396+00	2.641+00	2.614+09	1.233+09	2.803+05	5.366+04
5	1.800+09	4.226-01	3.319+10	4.094+02	1.427+00	2.677+00	3.329+09	1.530+09	2.938+05	5.999+04
6	2.160+09	4.167-01	3.779+10	4.272+02	1.454+00	2.711+00	4.039+09	1.828+09	3.054+05	6.571+04
7	2.520+09	4.115-01	4.216+10	4.446+02	1.478+00	2.742+00	4.746+09	2.127+09	3.155+05	7.097+04
8	2.880+09	4.068-01	4.636+10	4.617+02	1.499+00	2.771+00	5.448+09	2.427+09	3.245+05	7.587+04
9	3.240+09	4.026-01	5.0[illegible]2+10	4.786+02	1.518+00	2.798+00	6.149+09	2.727+09	3.327+05	8.047+04
10	3.600+09	3.988-01	5.423+10	4.959+02	1.534+00	2.823+00	6.848+09	3.027+09	3.401+05	8.466+04
11	3.960+09	3.952-01	5.805+10	5.126+02	1.551+00	2.848+00	7.542+09	3.328+09	3.472+05	8.879+04
12	4.320+09	3.918-01	6.180+10	5.292+02	1.566+00	2.872+00	8.234+09	3.629+09	3.536+05	9.276+04
13	4.680+09	3.886-01	6.546+10	5.456+02	1.580+00	2.895+00	8.924+09	3.931+09	3.600+05	9.656+04
14	5.040+09	3.855-01	6.905+10	5.621+02	1.593+00	2.917+00	9.613+09	4.233+09	3.659+05	1.002+05
15	5.400+09	3.827-01	7.258+10	5.784+02	1.606+00	2.938+00	1.030+10	4.535+09	3.714+05	1.038+05
16	5.760+09	3.800-01	7.605+10	5.948+02	1.618+00	2.959+00	1.099+10	4.838+09	3.768+05	1.072+05
17	6.120+09	3.774-01	7.946+10	6.111+02	1.630+00	2.979+00	1.167+10	5.140+09	3.819+05	1.105+05
18	6.480+09	3.749-01	8.282+10	6.274+02	1.640+00	2.999+00	1.236+10	5.443+09	3.868+05	1.137+05
19	6.840+09	3.725-01	8.614+10	6.437+02	1.651+00	3.018+00	1.304+10	5.745+09	3.915+05	1.168+05
20	7.200+09	3.703-01	8.941+10	6.601+02	1.661+00	3.036+00	1.373+10	6.048+09	3.961+05	1.199+05
21	7.560+09	3.681-01	9.264+10	6.764+02	1.671+00	3.054+00	1.441+10	6.351+09	4.005+05	1.228+05
22	7.920+09	3.660-01	9.584+10	6.927+02	1.680+00	3.072+00	1.509+10	6.654+09	4.047+05	1.257+05
23	8.280+09	3.640-01	9.900+10	7.091+02	1.689+00	3.089+00	1.578+10	6.957+09	4.089+05	1.286+05
24	8.640+09	3.621-01	1.021+11	7.255+02	1.697+00	3.106+00	1.646+10	7.260+09	4.129+05	1.313+05
25	9.000+09	3.602-01	1.052+11	7.419+02	1.706+00	3.122+00	1.714+10	7.563+09	4.168+05	1.341+05
26	9.360+09	3.584-01	1.083+11	7.583+02	1.714+00	3.138+00	1.783+10	7.866+09	4.206+05	1.367+05
27	9.720+09	3.566-01	1.113+11	7.748+02	1.722+00	3.154+00	1.851+10	8.169+09	4.243+05	1.393+05
28	1.008+10	3.549-01	1.144+11	7.913+02	1.729+00	3.170+00	1.919+10	8.472+09	4.280+05	1.419+05
29	1.044+10	3.533-01	1.174+11	8.078+02	1.737+00	3.185+00	1.988+10	8.775+09	4.315+05	1.444+05
30	1.080+10	3.517-01	1.203+11	8.243+02	1.744+00	3.200+00	2.056+10	9.077+09	4.350+05	1.469+05
31	1.116+10	3.501-01	1.233+11	8.409+02	1.751+00	3.214+00	2.124+10	9.380+09	4.384+05	1.493+05
32	1.152+10	3.486-01	1.262+11	8.575+02	1.758+00	3.229+00	2.193+10	9.683+09	4.417+05	1.517+05
33	1.188+10	3.471-01	1.291+11	8.741+02	1.764+00	3.243+00	2.261+10	9.986+09	4.449+05	1.541+05
34	1.224+10	3.457-01	1.320+11	8.908+02	1.771+00	3.257+00	2.330+10	1.029+10	4.481+05	1.564+05
35	1.260+10	3.443-01	1.349+11	9.075+02	1.777+00	3.271+00	2.398+10	1.059+10	4.513+05	1.587+05
36	1.296+10	3.429-01	1.377+11	9.242+02	1.783+00	3.285+00	2.467+10	1.089+10	4.544+05	1.609+05
37	1.332+10	3.416-01	1.406+11	9.410+02	1.789+00	3.298+00	2.535+10	1.120+10	4.574+05	1.632+05
38	1.368+10	3.403-01	1.434+11	9.578+02	1.795+00	3.311+00	2.604+10	1.150+10	4.604+05	1.654+05
39	1.404+10	3.390-01	1.462+11	9.746+02	1.801+00	3.324+00	2.673+10	1.180+10	4.633+05	1.675+05
40	1.440+10	3.377-01	1.490+11	9.915+02	1.807+00	3.337+00	2.741+10	1.210+10	4.662+05	1.697+05
41	1.476+10	3.365-01	1.517+11	1.008+03	1.812+00	3.350+00	2.810+10	1.241+10	4.690+05	1.718+05
42	1.512+10	3.353-01	1.545+11	1.025+03	1.818+00	3.363+00	2.879+10	1.271+10	4.718+05	1.739+05
43	1.548+10	3.341-01	1.572+11	1.042+03	1.823+00	3.375+00	2.947+10	1.301+10	4.746+05	1.759+05
44	1.584+10	3.330-01	1.600+11	1.059+03	1.828+00	3.387+00	3.016+10	1.331+10	4.773+05	1.780+05
45	1.620+10	3.319-01	1.627+11	1.076+03	1.833+00	3.399+00	3.085+10	1.361+10	4.800+05	1.800+05
46	1.656+10	3.308-01	1.654+11	1.093+03	1.838+00	3.411+00	3.154+10	1.392+10	4.826+05	1.820+05
47	1.692+10	3.297-01	1.681+11	1.111+03	1.843+00	3.423+00	3.223+10	1.422+10	4.852+05	1.839+05
48	1.728+10	3.286-01	1.708+11	1.128+03	1.848+00	3.435+00	3.292+10	1.452+10	4.878+05	1.859+05
49	1.764+10	3.276-01	1.735+11	1.145+03	1.853+00	3.446+00	3.361+10	1.482+10	4.904+05	1.878+05

TABLE B.5 (Continued)

15 Percent Water, 5 Percent Porosity Mixture (Continued)

50	1.800+10	3.266-01	1.761+11	1.162+03	1.857+00	3.458+00	3.430+10	1.512+10	4.929+05	1.897+05
51	1.836+10	3.256-01	1.788+11	1.179+03	1.862+00	3.469+00	3.499+10	1.542+10	4.954+05	1.916+05
52	1.872+10	3.246-01	1.814+11	1.197+03	1.867+00	3.480+00	3.569+10	1.573+10	4.978+05	1.935+05
53	1.908+10	3.236-01	1.840+11	1.214+03	1.871+00	3.491+00	3.638+10	1.603+10	5.002+05	1.954+05
54	1.944+10	3.227-01	1.867+11	1.231+03	1.875+00	3.502+00	3.707+10	1.633+10	5.026+05	1.972+05
55	1.980+10	3.217-01	1.893+11	1.249+03	1.880+00	3.513+00	3.776+10	1.663+10	5.050+05	1.990+05
56	2.016+10	3.208-01	1.919+11	1.266+03	1.884+00	3.524+00	3.846+10	1.693+10	5.074+05	2.008+05
57	2.052+10	3.199-01	1.945+11	1.283+03	1.888+00	3.535+00	3.915+10	1.723+10	5.097+05	2.026+05
58	2.088+10	3.190-01	1.970+11	1.301+03	1.892+00	3.545+00	3.985+10	1.753+10	5.120+05	2.044+05
59	2.124+10	3.181-01	1.996+11	1.318+03	1.897+00	3.556+00	4.054+10	1.783+10	5.142+05	2.061+05
60	2.160+10	3.173-01	2.022+11	1.336+03	1.901+00	3.566+00	4.124+10	1.813+10	5.165+05	2.079+05
61	2.196+10	3.164-01	2.048+11	1.354+03	1.905+00	3.576+00	4.193+10	1.844+10	5.187+05	2.096+05
62	2.232+10	3.156-01	2.073+11	1.371+03	1.908+00	3.586+00	4.263+10	1.874+10	5.209+05	2.113+05
63	2.268+10	3.148-01	2.098+11	1.389+03	1.912+00	3.597+00	4.333+10	1.904+10	5.231+05	2.130+05
64	2.304+10	3.140-01	2.124+11	1.406+03	1.916+00	3.607+00	4.403+10	1.934+10	5.253+05	2.147+05
65	2.340+10	3.132-01	2.149+11	1.424+03	1.920+00	3.616+00	4.473+10	1.964+10	5.274+05	2.164+05
66	2.376+10	3.124-01	2.174+11	1.442+03	1.924+00	3.626+00	4.542+10	1.994+10	5.295+05	2.180+05
67	2.412+10	3.116-01	2.199+11	1.460+03	1.927+00	3.636+00	4.612+10	2.024+10	5.317+05	2.197+05
68	2.448+10	3.108-01	2.225+11	1.477+03	1.931+00	3.646+00	4.682+10	2.054+10	5.337+05	2.213+05
69	2.484+10	3.101-01	2.250+11	1.495+03	1.935+00	3.655+00	4.752+10	2.084+10	5.358+05	2.229+05
70	2.520+10	3.093-01	2.274+11	1.513+03	1.938+00	3.665+00	4.823+10	2.114+10	5.379+05	2.245+05
71	2.556+10	3.086-01	2.299+11	1.531+03	1.942+00	3.674+00	4.893+10	2.144+10	5.399+05	2.261+05
72	2.592+10	3.079-01	2.324+11	1.549+03	1.945+00	3.684+00	4.963+10	2.174+10	5.419+05	2.277+05
73	2.628+10	3.071-01	2.349+11	1.567+03	1.949+00	3.693+00	5.033+10	2.204+10	5.439+05	2.293+05
74	2.664+10	3.064-01	2.374+11	1.585+03	1.952+00	3.702+00	5.104+10	2.233+10	5.459+05	2.309+05
75	2.700+10	3.057-01	2.398+11	1.603+03	1.955+00	3.712+00	5.174+10	2.263+10	5.479+05	2.324+05
76	2.736+10	3.050-01	2.423+11	1.621+03	1.959+00	3.721+00	5.244+10	2.293+10	5.498+05	2.340+05
77	2.772+10	3.044-01	2.447+11	1.639+03	1.962+00	3.730+00	5.315+10	2.323+10	5.518+05	2.355+05
78	2.808+10	3.037-01	2.472+11	1.657+03	1.965+00	3.739+00	5.385+10	2.353+10	5.537+05	2.370+05
79	2.844+10	3.030-01	2.496+11	1.675+03	1.968+00	3.748+00	5.456+10	2.383+10	5.556+05	2.385+05
80	2.880+10	3.024-01	2.520+11	1.693+03	1.972+00	3.757+00	5.527+10	2.413+10	5.575+05	2.401+05
81	2.916+10	3.017-01	2.545+11	1.711+03	1.975+00	3.765+00	5.597+10	2.443+10	5.594+05	2.415+05
82	2.952+10	3.011-01	2.569+11	1.729+03	1.978+00	3.774+00	5.668+10	2.473+10	5.613+05	2.430+05
83	2.988+10	3.004-01	2.593+11	1.748+03	1.981+00	3.783+00	5.739+10	2.503+10	5.631+05	2.445+05
84	3.024+10	2.998-01	2.617+11	1.766+03	1.984+00	3.791+00	5.810+10	2.532+10	5.650+05	2.460+05
85	3.060+10	2.992-01	2.641+11	1.784+03	1.987+00	3.800+00	5.881+10	2.562+10	5.668+05	2.474+05
86	3.096+10	2.986-01	2.665+11	1.802+03	1.990+00	3.808+00	5.952+10	2.592+10	5.686+05	2.489+05
87	3.132+10	2.980-01	2.689+11	1.821+03	1.993+00	3.817+00	6.023+10	2.622+10	5.704+05	2.503+05
88	3.168+10	2.974-01	2.713+11	1.839+03	1.996+00	3.825+00	6.094+10	2.652+10	5.722+05	2.518+05
89	3.204+10	2.968-01	2.737+11	1.857+03	1.999+00	3.834+00	6.165+10	2.681+10	5.740+05	2.532+05
90	3.240+10	2.962-01	2.761+11	1.876+03	2.002+00	3.842+00	6.236+10	2.711+10	5.758+05	2.546+05
91	3.276+10	2.956-01	2.785+11	1.894+03	2.005+00	3.850+00	6.307+10	2.741+10	5.775+05	2.560+05
92	3.312+10	2.950-01	2.808+11	1.913+03	2.008+00	3.859+00	6.379+10	2.771+10	5.793+05	2.574+05
93	3.348+10	2.944-01	2.832+11	1.931+03	2.010+00	3.867+00	6.450+10	2.801+10	5.810+05	2.588+05
94	3.384+10	2.939-01	2.856+11	1.950+03	2.013+00	3.875+00	6.521+10	2.830+10	5.827+05	2.602+05
95	3.420+10	2.933-01	2.879+11	1.968+03	2.016+00	3.883+00	6.593+10	2.860+10	5.845+05	2.616+05
96	3.456+10	2.928-01	2.903+11	1.987+03	2.019+00	3.891+00	6.664+10	2.890+10	5.862+05	2.630+05
97	3.492+10	2.922-01	2.927+11	2.005+03	2.021+00	3.899+00	6.736+10	2.920+10	5.879+05	2.643+05
98	3.528+10	2.917-01	2.950+11	2.024+03	2.024+00	3.907+00	6.808+10	2.949+10	5.895+05	2.657+05
99	3.564+10	2.911-01	2.973+11	2.043+03	2.027+00	3.915+00	6.879+10	2.979+10	5.912+05	2.671+05
100	3.600+10	2.906-01	2.997+11	2.061+03	2.029+00	3.923+00	6.951+10	3.009+10	5.929+05	2.684+05
101	3.636+10	2.901-01	3.020+11	2.080+03	2.032+00	3.930+00	7.023+10	3.038+10	5.945+05	2.697+05

TABLE B.5 (Continued)

25 PERCENT WATER, 20 PERCENT POROSITY MIXTURE

K	AIX	TVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	5.304-01	4.161+09	3.263+02	1.123+00	2.437+00	6.047+08	2.784+08	1.090+05	2.685+04
2	7.200+08	5.162-01	7.671+09	3.526+02	1.177+00	2.469+00	1.328+09	5.173+08	1.423+05	3.792+04
3	1.080+09	5.060-01	1.095+10	3.771+02	1.216+00	2.497+00	2.059+09	7.537+08	1.656+05	4.652+04
4	1.440+09	4.983-01	1.396+10	4.006+02	1.244+00	2.522+00	2.792+09	9.896+08	1.835+05	5.355+04
5	1.800+09	4.918-01	1.690+10	4.234+02	1.268+00	2.546+00	3.519+09	1.227+09	1.987+05	5.985+04
6	2.160+09	4.860-01	1.975+10	4.457+02	1.288+00	2.568+00	4.241+09	1.467+09	2.120+05	6.557+04
7	2.520+09	4.810-01	2.253+10	4.675+02	1.306+00	2.590+00	4.957+09	1.708+09	2.238+05	7.084+04
8	2.880+09	4.764-01	2.524+10	4.890+02	1.322+00	2.611+00	5.669+09	1.950+09	2.345+05	7.575+04
9	3.240+09	4.722-01	2.789+10	5.102+02	1.336+00	2.631+00	6.377+09	2.195+09	2.443+05	8.036+04
10	3.600+09	4.683-01	3.049+10	5.312+02	1.349+00	2.650+00	7.080+09	2.440+09	2.533+05	8.472+04
11	3.960+09	4.648-01	3.305+10	5.519+02	1.361+00	2.668+00	7.779+09	2.687+09	2.617+05	8.886+04
12	4.320+09	4.614-01	3.556+10	5.725+02	1.372+00	2.686+00	8.475+09	2.935+09	2.696+05	9.282+04
13	4.680+09	4.582-01	3.804+10	5.930+02	1.382+00	2.704+00	9.168+09	3.184+09	2.770+05	9.662+04
14	5.040+09	4.553-01	4.048+10	6.132+02	1.392+00	2.721+00	9.858+09	3.434+09	2.841+05	1.003+05
15	5.400+09	4.525-01	4.289+10	6.334+02	1.401+00	2.737+00	1.054+10	3.685+09	2.908+05	1.036+05
16	5.760+09	4.498-01	4.528+10	6.535+02	1.410+00	2.753+00	1.123+10	3.936+09	2.971+05	1.072+05
17	6.120+09	4.472-01	4.763+10	6.735+02	1.418+00	2.769+00	1.191+10	4.189+09	3.033+05	1.105+05
18	6.480+09	4.448-01	4.996+10	6.934+02	1.425+00	2.784+00	1.259+10	4.442+09	3.091+05	1.137+05
19	6.840+09	4.424-01	5.227+10	7.132+02	1.433+00	2.799+00	1.327+10	4.696+09	3.148+05	1.169+05
20	7.200+09	4.402-01	5.456+10	7.329+02	1.440+00	2.814+00	1.395+10	4.951+09	3.202+05	1.199+05
21	7.560+09	4.380-01	5.683+10	7.526+02	1.447+00	2.828+00	1.462+10	5.206+09	3.255+05	1.229+05
22	7.920+09	4.359-01	5.907+10	7.722+02	1.453+00	2.842+00	1.530+10	5.461+09	3.305+05	1.258+05
23	8.280+09	4.339-01	6.130+10	7.917+02	1.459+00	2.856+00	1.597+10	5.717+09	3.355+05	1.286+05
24	8.640+09	4.320-01	6.352+10	8.112+02	1.465+00	2.870+00	1.664+10	5.973+09	3.402+05	1.314+05
25	9.000+09	4.301-01	6.571+10	8.307+02	1.471+00	2.883+00	1.731+10	6.230+09	3.449+05	1.341+05
26	9.360+09	4.283-01	6.789+10	8.501+02	1.477+00	2.896+00	1.798+10	6.488+09	3.494+05	1.367+05
27	9.720+09	4.265-01	7.006+10	8.695+02	1.482+00	2.909+00	1.864+10	6.745+09	3.538+05	1.393+05
28	1.008+10	4.248-01	7.221+10	8.888+02	1.487+00	2.921+00	1.931+10	7.003+09	3.581+05	1.419+05
29	1.044+10	4.232-01	7.435+10	9.082+02	1.492+00	2.934+00	1.998+10	7.261+09	3.623+05	1.444+05
30	1.080+10	4.215-01	7.648+10	9.275+02	1.497+00	2.946+00	2.064+10	7.520+09	3.664+05	1.469+05
31	1.116+10	4.200-01	7.859+10	9.467+02	1.502+00	2.958+00	2.130+10	7.779+09	3.704+05	1.493+05
32	1.152+10	4.184-01	8.070+10	9.660+02	1.507+00	2.970+00	2.197+10	8.038+09	3.743+05	1.517+05
33	1.188+10	4.169-01	8.279+10	9.852+02	1.511+00	2.982+00	2.263+10	8.297+09	3.781+05	1.541+05
34	1.224+10	4.155-01	8.487+10	1.004+03	1.515+00	2.994+00	2.329+10	8.557+09	3.819+05	1.564+05
35	1.260+10	4.141-01	8.694+10	1.024+03	1.520+00	3.005+00	2.395+10	8.816+09	3.855+05	1.587+05
36	1.296+10	4.127-01	8.900+10	1.043+03	1.524+00	3.016+00	2.461+10	9.076+09	3.892+05	1.609+05
37	1.332+10	4.113-01	9.105+10	1.062+03	1.528+00	3.028+00	2.527+10	9.336+09	3.927+05	1.632+05
38	1.368+10	4.100-01	9.310+10	1.081+03	1.532+00	3.039+00	2.593+10	9.597+09	3.962+05	1.654+05
39	1.404+10	4.087-01	9.513+10	1.100+03	1.536+00	3.050+00	2.659+10	9.857+09	3.996+05	1.675+05
40	1.440+10	4.074-01	9.715+10	1.119+03	1.540+00	3.060+00	2.725+10	1.012+10	4.030+05	1.697+05
41	1.476+10	4.062-01	9.917+10	1.138+03	1.544+00	3.071+00	2.790+10	1.038+10	4.063+05	1.718+05
42	1.512+10	4.050-01	1.012+11	1.157+03	1.547+00	3.082+00	2.856+10	1.064+10	4.095+05	1.738+05
43	1.548+10	4.038-01	1.032+11	1.176+03	1.551+00	3.092+00	2.922+10	1.090+10	4.127+05	1.759+05
44	1.584+10	4.026-01	1.052+11	1.195+03	1.554+00	3.102+00	2.987+10	1.116+10	4.159+05	1.779+05
45	1.620+10	4.015-01	1.072+11	1.215+03	1.558+00	3.112+00	3.053+10	1.142+10	4.190+05	1.800+05
46	1.656+10	4.003-01	1.091+11	1.234+03	1.561+00	3.123+00	3.119+10	1.168+10	4.221+05	1.820+05
47	1.692+10	3.992-01	1.111+11	1.253+03	1.565+00	3.133+00	3.184+10	1.195+10	4.251+05	1.839+05
48	1.728+10	3.981-01	1.131+11	1.272+03	1.568+00	3.142+00	3.250+10	1.221+10	4.281+05	1.859+05
49	1.764+10	3.971-01	1.150+11	1.291+03	1.571+00	3.152+00	3.315+10	1.247+10	4.310+05	1.878+05

TABLE B.5 (Continued)

25 Percent Water, 20 Percent Porosity Mixture (Continued)

50	1.800+10	3.960-01	1.170+11	1.310+03	1.574+00	3.162+00	3.381+10	1.273+10	4.339+05	1.897+05
51	1.836+10	3.950-01	1.189+11	1.329+03	1.577+00	3.171+00	3.446+10	1.299+10	4.367+05	1.916+05
52	1.872+10	3.940-01	1.209+11	1.348+03	1.580+00	3.181+00	3.512+10	1.325+10	4.396+05	1.935+05
53	1.908+10	3.930-01	1.228+11	1.367+03	1.583+00	3.190+00	3.577+10	1.352+10	4.424+05	1.953+05
54	[illegible]	3.920-01	1.247+11	1.386+03	1.586+00	3.200+00	3.643+10	1.378+10	4.451+05	1.972+05
55	1.980+10	3.910-01	1.266+11	1.405+03	1.589+00	3.209+00	3.708+10	1.404+10	4.478+05	1.990+05
56	2.016+10	3.901-01	1.285+11	1.424+03	1.592+00	3.218+00	3.773+10	1.430+10	4.505+05	2.008+05
57	2.052+10	3.891-01	1.305+11	1.443+03	1.595+00	3.227+00	3.839+10	1.456+10	4.532+05	2.026+05
58	2.088+10	3.882-01	1.324+11	1.462+03	1.598+00	3.236+00	3.904+10	1.483+10	4.558+05	2.043+05
59	2.124+10	3.873-01	1.343+11	1.481+03	1.600+00	3.245+00	3.970+10	1.509+10	4.584+05	2.061+05
60	2.160+10	3.864-01	1.362+11	1.500+03	1.603+00	3.254+00	4.035+10	1.535+10	4.610+05	2.078+05
61	2.196+10	3.855-01	1.380+11	1.519+03	1.606+00	3.263+00	4.100+10	1.561+10	4.635+05	2.096+05
62	2.232+10	3.847-01	1.399+11	1.538+03	1.609+00	3.272+00	4.166+10	1.587+10	4.661+05	2.113+05
63	2.268+10	3.838-01	1.418+11	1.557+03	1.611+00	3.280+00	4.231+10	1.614+10	4.685+05	2.130+05
64	2.304+10	3.830-01	1.437+11	1.576+03	1.614+00	3.289+00	4.296+10	1.640+10	4.710+05	2.147+05
65	2.340+10	3.821-01	1.456+11	1.595+03	1.616+00	3.297+00	4.362+10	1.666+10	4.735+05	2.163+05
66	[illegible]	3.813-01	1.474+11	1.614+03	1.619+00	3.306+00	4.427+10	1.692+10	4.759+05	2.180+05
67	2.412+10	3.805-01	1.493+11	1.633+03	1.621+00	3.314+00	4.492+10	1.719+10	4.783+05	2.196+05
68	2.448+10	3.797-01	1.511+11	1.652+03	1.624+00	3.322+00	4.558+10	1.745+10	4.806+05	2.213+05
69	2.484+10	3.789-01	1.530+11	1.671+03	1.626+00	3.331+00	4.623+10	1.771+10	4.830+05	2.229+05
70	2.520+10	3.781-01	1.548+11	1.690+03	1.628+00	3.339+00	4.689+10	1.797+10	4.853+05	2.245+05
71	2.556+10	3.774-01	1.567+11	1.709+03	1.631+00	3.347+00	4.754+10	1.823+10	4.876+05	2.261+05
72	2.592+10	3.766-01	1.585+11	1.728+03	1.633+00	3.355+00	4.819+10	1.850+10	4.899+05	2.277+05
73	2.628+10	3.759-01	1.604+11	1.747+03	1.636+00	3.363+00	4.885+10	1.876+10	4.922+05	2.293+05
74	2.664+10	3.751-01	1.622+11	1.766+03	1.638+00	3.371+00	4.950+10	1.902+10	4.944+05	2.309+05
75	2.700+10	3.744-01	1.640+11	1.785+03	1.640+00	3.379+00	5.015+10	1.928+10	4.966+05	2.324+05
76	2.736+10	3.737-01	1.659+11	1.804+03	1.642+00	3.387+00	5.081+10	1.954+10	4.989+05	2.340+05
77	2.772+10	3.730-01	1.677+11	1.823+03	1.645+00	3.395+00	5.146+10	1.981+10	5.010+05	2.355+05
78	2.808+10	3.722-01	1.695+11	1.842+03	1.647+00	3.402+00	5.211+10	2.007+10	5.032+05	2.370+05
79	2.844+10	3.715-01	1.713+11	1.861+03	1.649+00	3.410+00	5.277+10	2.033+10	5.054+05	2.385+05
80	2.880+10	3.709-01	1.731+11	1.880+03	1.651+00	3.418+00	5.342+10	2.059+10	5.075+05	2.400+05
81	2.916+10	3.702-01	1.749+11	1.899+03	1.653+00	3.425+00	5.408+10	2.085+10	5.096+05	2.415+05
82	2.952+10	3.695-01	1.767+11	1.919+03	1.655+00	3.433+00	5.473+10	2.112+10	5.117+05	2.430+05
83	2.988+10	3.688-01	1.785+11	1.938+03	1.657+00	3.440+00	5.538+10	2.138+10	5.138+05	2.445+05
84	3.024+10	3.682-01	1.803+11	1.957+03	1.660+00	3.448+00	5.604+10	2.164+10	5.159+05	2.460+05
85	3.060+10	3.675-01	1.821+11	1.976+03	1.662+00	3.455+00	5.669+10	2.190+10	5.179+05	2.474+05
86	3.096+10	3.669-01	1.839+11	1.995+03	1.664+00	3.463+00	5.735+10	2.216+10	5.200+05	2.489+05
87	3.132+10	3.662-01	1.857+11	2.014+03	1.666+00	3.470+00	5.800+10	2.243+10	5.220+05	2.503+05
88	3.168+10	3.656-01	1.875+11	2.033+03	1.668+00	3.477+00	5.866+10	2.269+10	5.240+05	2.518+05
89	3.204+10	3.650-01	1.893+11	2.052+03	1.670+00	3.485+00	5.931+10	2.295+10	5.260+05	2.532+05
90	3.240+10	3.643-01	1.911+11	2.071+03	1.672+00	3.492+00	5.997+10	2.321+10	5.280+05	2.546+05
91	3.276+10	3.637-01	1.928+11	2.090+03	1.674+00	3.499+00	6.062+10	2.347+10	5.300+05	2.560+05
92	3.312+10	3.631-01	1.946+11	2.109+03	1.676+00	3.506+00	6.128+10	2.373+10	5.319+05	2.574+05
93	3.348+10	3.625-01	1.964+11	2.128+03	1.677+00	3.513+00	6.193+10	2.400+10	5.339+05	2.588+05
94	3.384+10	3.619-01	1.981+11	2.148+03	1.679+00	3.520+00	6.259+10	2.426+10	5.358+05	2.602+05
95	3.420+10	3.613-01	1.999+11	2.167+03	1.681+00	3.527+00	6.324+10	2.452+10	5.377+05	2.616+05
96	3.456+10	3.607-01	2.017+11	2.186+03	1.683+00	3.534+00	6.390+10	2.478+10	5.396+05	2.630+05
97	3.492+10	3.602-01	2.034+11	2.205+03	1.685+00	3.541+00	6.455+10	2.504+10	5.415+05	2.644+05
98	3.528+10	3.596-01	2.052+11	2.224+03	1.687+00	3.548+00	6.521+10	2.530+10	5.434+05	2.657+05
99	3.564+10	3.590-01	2.069+11	2.243+03	1.689+00	3.555+00	6.587+10	2.556+10	5.453+05	2.671+05
100	3.600+10	3.585-01	2.087+11	2.262+03	1.691+00	3.562+00	6.652+10	2.583+10	5.471+05	2.684+05
101	3.636+10	3.585-01	2.096+11	2.286+03	1.689+00	3.564+00	6.726+10	2.606+10	5.483+05	2.690+05
102	3.672+10	3.574-01	2.124+11	2.300+03	1.692+00	3.577+00	6.777+10	2.637+10	5.511+05	2.712+05
103	3.708+10	3.568-01	2.140+11	2.320+03	1.696+00	3.582+00	6.848+10	2.661+10	5.527+05	2.725+05

NOT REPRODUCIBLE

TABLE B.5 (Continued)

25 Percent Water, 20 Percent Porosity Mixture (Continued)

104	3.744+10	3.568-01	2.148+11	2.343+03	1.694+00	3.584+00	6.923+10	2.684+10	5.538+05	2.730+05
105	3.780+10	3.558-01	2.176+11	2.357+03	1.698+00	3.597+00	6.974+10	2.715+10	5.565+05	2.752+05
106	3.816+10	3.552-01	2.192+11	2.377+03	1.701+00	3.602+00	7.045+10	2.740+10	5.581+05	2.764+05
107	3.852+10	3.552-01	2.200+11	2.401+03	1.700+00	3.604+00	7.120+10	2.763+10	5.591+05	2.769+05
108	3.888+10	3.542-01	2.228+11	2.415+03	1.703+00	3.617+00	7.171+10	2.794+10	5.619+05	2.791+05
109	3.924+10	3.536-01	2.244+11	2.435+03	1.706+00	3.622+00	7.242+10	2.818+10	5.634+05	2.803+05
110	3.960+10	3.536-01	2.252+11	2.458+03	1.705+00	3.624+00	7.318+10	2.841+10	5.644+05	2.808+05
111	3.996+10	3.526-01	2.280+11	2.472+03	1.708+00	3.636+00	7.368+10	2.872+10	5.671+05	2.829+05
112	4.032+10	3.520-01	2.296+11	2.492+03	1.711+00	3.641+00	7.439+10	2.896+10	5.686+05	2.841+05
113	4.068+10	3.520-01	2.304+11	2.516+03	1.710+00	3.643+00	7.515+10	2.919+10	5.696+05	2.846+05
114	4.104+10	3.511-01	2.332+11	2.530+03	1.713+00	3.655+00	7.566+10	2.950+10	5.723+05	2.867+05
115	4.140+10	3.505-01	2.348+11	2.550+03	1.717+00	3.660+00	7.637+10	2.974+10	5.737+05	2.879+05
116	4.176+10	3.505-01	2.355+11	2.574+03	1.716+00	3.662+00	7.713+10	2.997+10	5.747+05	2.884+05
117	4.212+10	3.496-01	2.383+11	2.588+03	1.718+00	3.674+00	7.763+10	3.028+10	5.774+05	2.905+05
118	4.248+10	3.496-01	2.388+11	2.613+03	1.718+00	3.674+00	7.847+10	3.048+10	5.779+05	2.908+05
119	4.284+10	3.487-01	2.418+11	2.626+03	1.721+00	3.687+00	7.893+10	3.081+10	5.808+05	2.930+05
120	4.320+10	3.487-01	2.422+11	2.652+03	1.722+00	3.686+00	7.980+10	3.100+10	5.812+05	2.932+05
121	4.356+10	3.477-01	2.452+11	2.669+03	1.724+00	3.700+00	8.025+10	3.133+10	5.841+05	2.954+05
122	4.392+10	3.477-01	2.456+11	2.690+03	1.725+00	3.698+00	8.112+10	3.152+10	5.845+05	2.956+05
123	4.428+10	3.468-01	2.487+11	2.703+03	1.727+00	3.712+00	8.156+10	3.185+10	5.874+05	2.979+05
124	4.464+10	3.468-01	2.490+11	2.729+03	1.728+00	3.710+00	8.244+10	3.204+10	5.877+05	2.981+05
125	4.500+10	3.459-01	2.521+11	2.741+03	1.730+00	3.724+00	8.288+10	3.237+10	5.906+05	3.003+05
126	4.536+10	3.459-01	2.523+11	2.768+0[illegible]	[illegible]	3.722+00	8.377+10	3.256+10	5.910+05	3.005+05
127	4.572+10	3.450-01	2.554+11	[illegible]	1.733+00	3.736+00	8.420+10	3.289+10	5.938+05	3.027+05
128	4.608+10	3.450-01	2.557+11	[illegible]	1.735+00	3.734+00	8.509+10	3.308+10	5.941+05	3.029+05
129	4.644+10	3.441-01	2.588+11	[illegible]	1.736+00	3.748+00	8.552+10	3.341+10	5.970+05	3.051+05
130	4.680+10	3.441-01	2.591+11	2.845+03	1.738+00	3.746+00	8.641+10	3.360+10	5.973+05	3.052+05
131	4.716+10	3.432-01	2.622+11	2.857+03	1.739+00	3.760+00	8.684+10	3.393+10	6.002+05	3.074+05
132	4.752+10	3.432-01	2.624+11	2.884+03	1.741+00	3.757+00	8.774+10	3.411+10	6.004+05	3.076+05
133	4.788+10	3.423-01	2.656+11	2.896+03	1.742+00	3.772+00	8.816+10	3.445+10	6.033+05	3.098+05
134	4.824+10	3.423-01	2.658+11	2.922+03	1.744+00	3.769+00	8.907+10	3.463+10	6.035+05	3.099+05
135	4.860+10	3.415-01	2.689+11	2.934+03	1.745+00	3.784+00	8.948+10	3.497+10	6.064+05	3.121+05
136	4.896+10	3.415-01	2.691+11	2.961+03	1.747+00	3.781+00	9.039+10	3.515+10	6.066+05	3.122+05
137	4.932+10	3.406-01	2.723+11	2.973+03	1.748+00	3.795+00	9.080+10	3.549+10	6.094+05	3.144+05
138	4.968+10	3.406-01	2.725+11	3.000+03	1.750+00	3.792+00	9.172+10	3.567+10	6.096+05	3.145+05
139	5.004+10	3.398-01	2.756+11	3.012+03	1.751+00	3.807+00	9.213+10	3.601+10	6.124+05	3.167+05
140	5.040+10	3.398-01	2.758+11	3.039+03	1.753+00	3.803+00	9.305+10	3.618+10	6.126+05	3.168+05
141	5.076+10	3.390-01	2.790+11	3.050+03	1.754+00	3.818+00	9.345+10	3.653+10	6.155+05	3.190+05
142	5.112+10	3.390-01	2.791+11	3.077+03	1.756+00	3.815+00	9.438+10	3.670+10	6.156+05	3.191+05
143	5.148+10	3.382-01	2.823+11	3.089+03	1.757+00	3.829+00	9.478+10	3.705+10	6.184+05	3.212+05
144	5.184+10	3.382-01	2.824+11	3.116+03	1.759+00	3.826+00	9.571+10	3.722+10	6.186+05	3.213+05
145	5.220+10	3.374-01	2.857+11	3.128+03	1.760+00	3.840+00	9.610+10	3.757+10	6.214+05	3.235+05
146	5.256+10	3.374-01	2.858+11	3.155+03	1.762+00	3.837+00	9.704+10	3.773+10	6.215+05	3.235+05
147	5.292+10	3.366-01	2.890+11	3.167+03	1.763+00	3.852+00	9.743+10	3.808+10	6.243+05	3.257+05
148	5.328+10	3.366-01	2.891+11	3.194+03	1.765+00	3.848+00	9.837+10	3.825+10	6.244+05	3.258+05
149	5.364+10	3.358-01	2.923+11	3.205+03	1.766+00	3.863+00	9.876+10	3.860+10	6.272+05	3.279+05
150	5.400+10	3.358-01	2.924+11	3.233+03	1.768+00	3.859+00	9.971+10	3.876+10	6.273+05	3.280+05
151	5.436+10	3.352-01	2.949+11	3.248+03	1.770+00	3.868+00	1.003+11	3.906+10	6.299+05	3.296+05
152	5.472+10	3.352-01	2.955+11	3.272+03	1.769+00	3.870+00	1.010+11	3.929+10	6.302+05	3.300+05
153	5.508+10	3.344-01	2.983+11	3.287+03	1.771+00	3.880+00	1.015+11	3.959+10	6.325+05	3.319+05
154	5.544+10	3.338-01	3.004+11	3.303+03	1.774+00	3.889+00	1.021+11	3.988+10	6.342+05	3.334+05

TABLE B.5 (Continued)

25 PERCENT WATER, 15 PERCENT POROSITY MIXTURE

K	AIR	IVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	5.245-01	5.237+09	3.272+02	1.146+00	2.447+00	5.699+08	2.900+08	1.291+05	2.686+04
2	7.200+08	5.093-01	9.395+09	3.527+02	1.205+00	2.484+00	1.278+09	5.339+08	1.641+05	3.791+04
3	1.080+09	4.985-01	1.320+10	3.762+02	1.247+00	2.517+00	1.992+09	7.762+08	1.880+05	4.650+04
4	1.440+09	4.903-01	1.668+10	3.986+02	1.278+00	2.545+00	2.705+09	1.018+09	2.063+05	5.356+04
5	1.800+09	4.834-01	2.003+10	4.202+02	1.303+00	2.572+00	3.411+09	1.263+09	2.216+05	5.985+04
6	2.160+09	4.774-01	2.325+10	4.412+02	1.325+00	2.597+00	4.112+09	1.509+09	2.349+05	6.557+04
7	2.520+09	4.720-01	2.637+10	4.618+02	1.345+00	2.621+00	4.808+09	1.757+09	2.466+05	7.084+04
8	2.880+09	4.672-01	2.941+10	4.820+02	1.362+00	2.644+00	5.498+09	2.007+09	2.572+05	7.574+04
9	3.240+09	4.628-01	3.237+10	5.020+02	1.377+00	2.666+00	6.184+09	2.259+09	2.668+05	8.035+04
10	3.600+09	4.588-01	3.526+10	5.217+02	1.392+00	2.687+00	6.867+09	2.511+09	2.757+05	8.471+04
11	3.960+09	4.550-01	3.809+10	5.412+02	1.405+00	2.707+00	7.545+09	2.765+09	2.839+05	8.886+04
12	4.320+09	4.515-01	4.087+10	5.605+02	1.417+00	2.726+00	8.221+09	3.020+09	2.917+05	9.282+04
13	4.680+09	4.482-01	4.361+10	5.796+02	1.429+00	2.745+00	8.894+09	3.275+09	2.989+05	9.662+04
14	5.040+09	4.451-01	4.630+10	5.987+02	1.439+00	2.763+00	9.564+09	3.532+09	3.058+05	1.003+05
15	5.400+09	4.422-01	4.895+10	6.176+02	1.449+00	2.781+00	1.023+10	3.789+09	3.123+05	1.038+05
16	5.760+09	4.394-01	5.157+10	6.364+02	1.459+00	2.798+00	1.090+10	4.048+09	3.186+05	1.072+05
17	6.120+09	4.367-01	5.415+10	6.551+02	1.468+00	2.815+00	1.156+10	4.306+09	3.245+05	1.105+05
18	6.480+09	4.342-01	5.671+10	6.738+02	1.477+00	2.831+00	1.222+10	4.566+09	3.302+05	1.137+05
19	6.840+09	4.317-01	5.923+10	6.924+02	1.485+00	2.847+00	1.288+10	4.826+09	3.357+05	1.169+05
20	7.200+09	4.294-01	6.173+10	7.109+02	1.493+00	2.863+00	1.354+10	5.086+09	3.410+05	1.199+05
21	7.560+09	4.272-01	6.420+10	7.293+02	1.501+00	2.878+00	1.420+10	5.347+09	3.461+05	1.229+05
22	7.920+09	4.250-01	6.665+10	7.478+02	1.508+00	2.893+00	1.486+10	5.608+09	3.510+05	1.258+05
23	8.280+09	4.229-01	6.908+10	7.661+02	1.515+00	2.907+00	1.551+10	5.870+09	3.558+05	1.286+05
24	8.640+09	4.209-01	7.149+10	7.844+02	1.522+00	2.922+00	1.617+10	6.132+09	3.604+05	1.314+05
25	9.000+09	4.190-01	7.388+10	8.027+02	1.529+00	2.936+00	1.682+10	6.394+09	3.649+05	1.341+05
26	9.360+09	4.171-01	7.625+10	8.210+02	1.535+00	2.950+00	1.747+10	6.656+09	3.693+05	1.367+05
27	9.720+09	4.152-01	7.860+10	8.392+02	1.542+00	2.963+00	1.812+10	6.919+09	3.736+05	1.394+05
28	1.008+10	4.135-01	8.094+10	8.574+02	1.548+00	2.977+00	1.877+10	7.182+09	3.777+05	1.419+05
29	1.044+10	4.118-01	8.326+10	8.756+02	1.554+00	2.990+00	1.942+10	7.445+09	3.818+05	1.444+05
30	1.080+10	4.101-01	8.556+10	8.937+02	1.559+00	3.003+00	2.007+10	7.709+09	3.858+05	1.469+05
31	1.116+10	4.085-01	8.785+10	9.119+02	1.565+00	3.016+00	2.072+10	7.973+09	3.896+05	1.493+05
32	1.152+10	4.069-01	9.013+10	9.300+02	1.571+00	3.028+00	2.137+10	8.236+09	3.934+05	1.517+05
33	1.188+10	4.053-01	9.239+10	9.481+02	1.576+00	3.040+00	2.202+10	8.500+09	3.971+05	1.541+05
34	1.224+10	4.038-01	9.464+10	9.662+02	1.581+00	3.053+00	2.267+10	8.764+09	4.008+05	1.564+05
35	1.260+10	4.023-01	9.688+10	9.843+02	1.586+00	3.065+00	2.331+10	9.029+09	4.043+05	1.587+05
36	1.296+10	4.009-01	9.910+10	1.002+03	1.591+00	3.076+00	2.396+10	9.293+09	4.078+05	1.609+05
37	1.332+10	3.995-01	1.013+11	1.020+03	1.596+00	3.088+00	2.461+10	9.557+09	4.112+05	1.632+05
38	1.368+10	3.981-01	1.035+11	1.038+03	1.601+00	3.100+00	2.525+10	9.822+09	4.146+05	1.654+05
39	1.404+10	3.968-01	1.057+11	1.056+03	1.605+00	3.111+00	2.590+10	1.009+10	4.179+05	1.675+05
40	1.440+10	3.955-01	1.079+11	1.075+03	1.610+00	3.122+00	2.655+10	1.035+10	4.212+05	1.697+05
41	1.476+10	3.942-01	1.101+11	1.093+03	1.614+00	3.134+00	2.719+10	1.062+10	4.244+05	1.718+05
42	1.512+10	3.929-01	1.122+11	1.111+03	1.619+00	3.145+00	2.784+10	1.088+10	4.275+05	1.739+05
43	1.548+10	3.917-01	1.144+11	1.129+03	1.623+00	3.155+00	2.848+10	1.115+10	4.306+05	1.759+05
44	1.584+10	3.905-01	1.165+11	1.147+03	1.627+00	3.166+00	2.913+10	1.141+10	4.337+05	1.780+05
45	1.620+10	3.893-01	1.187+11	1.165+03	1.632+00	3.177+00	2.977+10	1.168+10	4.367+05	1.800+05
46	1.656+10	3.881-01	1.208+11	1.183+03	1.636+00	3.187+00	3.042+10	1.194+10	4.396+05	1.820+05
47	1.692+10	3.870-01	1.229+11	1.201+03	1.640+00	3.198+00	3.106+10	1.221+10	4.425+05	1.839+05
48	1.728+10	3.859-01	1.250+11	1.219+03	1.644+00	3.208+00	3.171+10	1.247+10	4.454+05	1.859+05
49	1.764+10	3.848-01	1.271+11	1.237+03	1.648+00	3.218+00	3.235+10	1.274+10	4.483+05	1.878+05

TABLE B.5 (Continued)

25 Percent Water, 15 Percent Porosity Mixture (Continued)

50	1.800+10	3.837-01	1.292+11	1.255+03	1.652+00	3.228+00	3.300+10	1.300+10	4.511+05	1.897+05
51	1.836+10	3.826-01	[illegible]	1.273+03	1.655+00	3.238+00	3.364+10	1.327+10	4.538+05	1.916+05
52	1.872+10	3.816-01	1.334+11	1.291+03	1.659+00	3.248+00	3.429+10	1.353+10	4.565+05	1.935+05
53	1.908+10	3.806-01	1.355+11	1.309+03	1.663+00	3.258+00	3.493+10	1.380+10	4.592+05	1.954+05
54	1.944+10	3.796-01	1.375+11	1.327+03	1.666+00	3.268+00	3.558+10	1.406+10	4.619+05	1.972+05
55	1.980+10	3.786-01	1.396+11	1.345+03	1.670+00	3.277+00	3.622+10	1.433+10	4.645+05	1.990+05
56	2.016+10	3.776-01	1.416+11	1.363+03	1.673+00	3.287+00	3.687+10	1.459+10	4.671+05	2.008+05
57	2.052+10	3.766-01	1.437+11	1.381+03	1.677+00	3.296+00	3.752+10	1.485+10	4.697+05	2.026+05
58	2.088+10	3.757-01	1.457+11	1.399+03	1.680+00	3.305+00	3.816+10	1.512+10	4.722+05	2.044+05
59	2.124+10	3.747-01	1.478+11	1.417+03	1.684+00	3.315+00	3.881+10	1.538+10	4.748+05	2.061+05
60	2.160+10	3.738-01	1.498+11	1.435+03	1.687+00	3.324+00	3.945+10	1.565+10	4.772+05	2.079+05
61	2.196+10	3.729-01	1.518+11	1.453+03	1.690+00	3.333+00	4.010+10	1.591+10	4.797+05	2.096+05
62	2.232+10	3.720-01	1.538+11	1.471+03	1.694+00	3.342+00	4.074+10	1.618+10	4.821+05	2.113+05
63	2.268+10	3.711-01	1.558+11	1.489+03	1.697+00	3.351+00	4.139+10	1.644+10	4.845+05	2.130+05
64	2.304+10	3.703-01	1.578+11	1.507+03	1.700+00	3.360+00	4.203+10	1.671+10	4.869+05	2.147+05
65	2.340+10	3.694-01	1.599+11	1.525+03	1.703+00	3.369+00	4.268+10	1.697+10	4.893+05	2.164+05
66	2.376+10	3.686-01	1.618+11	1.543+03	1.706+00	3.377+00	4.333+10	1.724+10	4.916+05	2.180+05
67	2.412+10	3.677-01	1.638+11	1.561+03	1.710+00	3.386+00	4.397+10	1.750+10	4.939+05	2.197+05
68	2.448+10	3.669-01	1.658+11	1.580+03	1.713+00	3.395+00	4.462+10	1.777+10	4.962+05	2.213+05
69	2.484+10	3.661-01	1.678+11	1.598+03	1.716+00	3.403+00	4.527+10	1.803+10	4.985+05	2.229+05
70	2.520+10	3.653-01	1.698+11	1.616+03	1.719+00	3.412+00	4.591+10	1.830+10	5.007+05	2.246+05
71	2.556+10	3.645-01	1.718+11	1.634+03	1.722+00	3.420+00	4.656+10	1.856+10	5.030+05	2.262+05
72	2.592+10	3.637-01	1.737+11	1.652+03	1.725+00	3.428+00	4.721+10	1.882+10	5.052+05	2.277+05
73	2.628+10	3.629-01	1.757+11	1.670+03	1.727+00	3.437+00	4.785+10	1.909+10	5.074+05	2.293+05
74	2.664+10	3.622-01	1.776+11	1.688+03	1.730+00	3.445+00	4.850+10	1.935+10	5.095+05	2.309+05
75	2.700+10	3.614-01	1.796+11	1.706+03	1.733+00	3.453+00	4.915+10	1.962+10	5.117+05	2.324+05
76	2.736+10	3.607-01	1.815+11	1.725+03	1.736+00	3.461+00	4.980+10	1.988+10	5.138+05	2.340+05
77	2.772+10	3.600-01	1.835+11	1.743+03	1.739+00	3.469+00	5.044+10	2.015+10	5.159+05	2.355+05
78	2.808+10	3.592-01	1.854+11	1.761+03	1.742+00	3.477+00	5.109+10	2.041+10	5.180+05	2.371+05
79	2.844+10	3.585-01	1.874+11	1.779+03	1.744+00	3.485+00	5.174+10	2.067+10	5.201+05	2.386+05
80	2.880+10	3.578-01	1.893+11	1.797+03	1.747+00	3.493+00	5.239+10	2.094+10	5.222+05	2.401+05
81	2.916+10	3.571-01	1.912+11	1.815+03	1.750+00	3.501+00	5.304+10	2.120+10	5.242+05	2.416+05
82	2.952+10	3.564-01	1.931+11	1.833+03	1.752+00	3.509+00	5.369+10	2.146+10	5.263+05	2.431+05
83	2.988+10	3.557-01	1.951+11	1.852+03	1.755+00	3.517+00	5.434+10	2.173+10	5.283+05	2.445+05
84	3.024+10	3.550-01	1.970+11	1.870+03	1.758+00	3.524+00	5.498+10	2.199+10	5.303+05	2.460+05
85	3.060+10	3.544-01	1.989+11	1.888+03	1.760+00	3.532+00	5.563+10	2.226+10	5.323+05	2.475+05
86	3.096+10	3.537-01	2.008+11	1.906+03	1.763+00	3.540+00	5.628+10	2.252+10	5.343+05	2.489+05
87	3.132+10	3.530-01	2.027+11	1.924+03	1.765+00	3.547+00	5.693+10	2.278+10	5.362+05	2.504+05
88	3.168+10	3.524-01	2.046+11	1.943+03	1.768+00	3.555+00	5.758+10	2.305+10	5.382+05	2.518+05
89	3.204+10	3.518-01	2.065+11	1.961+03	1.771+00	3.562+00	5.823+10	2.331+10	5.401+05	2.532+05
90	3.240+10	3.511-01	2.084+11	1.979+03	1.773+00	3.570+00	5.888+10	2.357+10	5.420+05	2.547+05
91	3.276+10	3.505-01	2.103+11	1.997+03	1.776+00	3.577+00	5.954+10	2.383+10	5.439+05	2.561+05
92	3.312+10	3.499-01	2.122+11	2.016+03	1.778+00	3.584+00	6.019+10	2.410+10	5.458+05	2.575+05
93	3.348+10	3.492-01	2.141+11	2.034+03	1.780+00	3.592+00	6.084+10	2.436+10	5.477+05	2.589+05
94	3.384+10	3.486-01	2.160+11	2.052+03	1.783+00	3.599+00	6.149+10	2.462+10	5.496+05	2.603+05
95	3.420+10	3.480-01	2.178+11	2.070+03	1.785+00	3.606+00	6.214+10	2.489+10	5.514+05	2.617+05
96	3.456+10	3.474-01	2.197+11	2.089+03	1.788+00	3.613+00	6.279+10	2.515+10	5.532+05	2.630+05
97	3.492+10	3.468-01	2.216+11	2.107+03	1.790+00	3.620+00	6.344+10	2.541+10	5.551+05	2.644+05
98	3.528+10	3.462-01	2.235+11	2.125+03	1.792+00	3.627+00	6.410+10	2.567+10	5.569+05	2.658+05
99	3.564+10	3.457-01	2.253+11	2.144+03	1.795+00	3.634+00	6.475+10	2.594+10	5.587+05	2.671+05
100	3.600+10	3.451-01	2.272+11	2.162+03	1.797+00	3.641+00	6.540+10	2.620+10	5.605+05	2.685+05
101	3.636+10	3.445-01	2.291+11	2.180+03	1.799+00	3.648+00	6.605+10	2.646+10	5.623+05	2.698+05
102	3.672+10	3.439-01	2.309+11	2.199+03	1.802+00	3.655+00	6.671+10	2.672+10	5.641+05	2.711+05
103	3.708+10	3.434-01	2.328+11	2.217+03	1.804+00	3.662+00	6.736+10	2.699+10	5.658+05	2.725+05

TABLE B.5 (Continued)

25 Percent Water, 15 Percent Porosity Mixture (Continued)

104	3.744+10	3.428-01	2.346+11	2.235+03	1.806+00	3.667+00	6.801+10	2.725+10	5.676+05	2.738+05
105	3.780+10	3.423-01	2.365+11	2.254+03	1.808+00	3.676+00	6.867+10	2.751+10	5.693+05	2.751+05
106	3.816+10	3.417-01	2.383+11	2.272+03	1.811+00	3.683+00	6.932+10	2.777+10	5.710+05	2.764+05
107	3.852+10	3.412-01	2.402+11	2.290+03	1.813+00	3.687+00	6.998+10	2.803+10	5.728+05	2.777+05
108	3.888+10	3.406-01	2.420+11	2.309+03	1.815+00	3.694+00	7.063+10	2.830+10	5.745+05	2.790+05
109	3.924+10	3.401-01	2.438+11	2.327+03	1.817+00	3.703+00	7.128+10	2.856+10	5.762+05	2.803+05
110	3.960+10	3.396-01	2.457+11	2.345+03	1.820+00	3.710+00	7.194+10	2.882+10	5.779+05	2.816+05
111	3.996+10	3.391-01	2.475+11	2.364+03	1.822+00	3.716+00	7.260+10	2.908+10	5.796+05	2.829+05
112	4.032+10	3.385-01	2.493+11	2.382+03	1.824+00	3.723+00	7.325+10	2.934+10	5.812+05	2.841+05
113	4.068+10	3.380-01	2.512+11	2.401+03	1.826+00	3.729+00	7.391+10	2.960+10	5.829+05	2.854+05
114	4.104+10	3.375-01	2.530+11	2.419+03	1.828+00	3.734+00	7.456+10	2.987+10	5.845+05	2.867+05
115	4.140+10	3.370-01	2.548+11	2.438+03	1.830+00	3.742+00	7.522+10	3.013+10	5.862+05	2.879+05
116	4.176+10	3.365-01	2.567+11	2.456+03	1.832+00	3.749+00	7.587+10	3.039+10	5.878+05	2.892+05
117	4.212+10	3.365-01	2.573+11	2.481+03	1.832+00	3.749+00	7.667+10	3.060+10	5.886+05	2.895+05
118	4.248+10	3.356-01	2.606+11	2.492+03	1.833+00	3.764+00	7.709+10	3.094+10	5.915+05	2.918+05
119	4.284+10	3.350-01	2.622+11	2.511+03	1.838+00	3.769+00	7.782+10	3.118+10	5.928+05	2.930+05
120	4.320+10	3.350-01	2.627+11	2.536+03	1.838+00	3.768+00	7.865+10	3.139+10	5.934+05	2.932+05
121	4.356+10	3.342-01	2.660+11	2.548+03	1.840+00	3.783+00	7.906+10	3.173+10	5.963+05	2.954+05
122	4.392+10	3.336-01	2.677+11	2.566+03	1.844+00	3.788+00	7.979+10	3.196+10	5.976+05	2.966+05
123	4.428+10	3.336-01	2.681+11	2.591+03	1.845+00	3.787+00	8.062+10	3.217+10	5.981+05	2.969+05
124	4.464+10	3.327-01	2.714+11	2.603+03	1.846+00	3.802+00	8.103+10	3.251+10	6.010+05	2.991+05
125	4.500+10	3.322-01	2.731+11	2.622+03	1.850+00	3.807+00	8.176+10	3.275+10	6.024+05	3.003+05
126	4.536+10	3.322-01	2.735+11	2.647+03	1.851+00	3.806+00	8.260+10	3.295+10	6.028+05	3.005+05
127	4.572+10	3.313-01	2.768+11	2.659+03	1.852+00	3.820+00	8.300+10	3.329+10	6.057+05	3.027+05
128	4.608+10	3.308-01	2.785+11	2.677+03	1.856+00	3.825+00	8.374+10	3.353+10	6.070+05	3.039+05
129	4.644+10	3.308-01	2.789+11	2.703+03	1.857+00	3.824+00	8.458+10	3.373+10	6.075+05	3.041+05
130	4.680+10	3.300-01	2.822+11	2.714+03	1.857+00	3.839+00	8.498+10	3.407+10	6.103+05	3.062+05
131	4.716+10	3.294-01	2.839+11	2.733+03	1.862+00	3.843+00	8.571+10	3.431+10	6.116+05	3.074+05
132	4.752+10	3.294-01	2.843+11	2.758+03	1.863+00	3.842+00	8.657+10	3.450+10	6.120+05	3.076+05
133	4.788+10	3.286-01	2.876+11	2.770+03	1.863+00	3.857+00	8.696+10	3.485+10	6.149+05	3.098+05
134	4.824+10	3.281-01	2.892+11	2.789+03	1.868+00	3.861+00	8.769+10	3.509+10	6.161+05	3.109+05
135	4.860+10	3.281-01	2.896+11	2.814+03	1.868+00	3.860+00	8.855+10	3.528+10	6.165+05	3.111+05
136	4.896+10	3.273-01	2.929+11	2.826+03	1.869+00	3.875+00	8.894+10	3.563+10	6.193+05	3.132+05
137	4.932+10	3.268-01	2.946+11	2.844+03	1.873+00	3.879+00	8.968+10	3.587+10	6.206+05	3.144+05
138	4.968+10	3.268-01	2.949+11	2.870+03	1.874+00	3.878+00	9.059+10	3.606+10	6.210+05	3.146+05
139	5.004+10	3.261-01	2.983+11	2.881+03	1.875+00	3.892+00	9.092+10	3.641+10	6.238+05	3.167+05
140	5.040+10	3.255-01	2.999+11	2.900+03	1.879+00	3.897+00	9.166+10	3.665+10	6.250+05	3.178+05
141	5.076+10	3.255-01	3.002+11	2.926+03	1.880+00	3.895+00	9.253+10	3.684+10	6.253+05	3.180+05

TABLE B.5 (Continued)

25 PERCENT WATER, 10 PERCENT POROSITY MIXTURE

K	AIX	TVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	5.177-01	6.645+09	3.279+02	1.175+00	2.460+00	5.275+08	3.041+08	1.553+05	2.677+04
2	7.200+08	5.013-01	1.165+10	3.521+02	1.238+00	2.504+00	1.214+09	5.554+08	1.916+05	3.803+04
3	1.080+09	4.902-01	1.599+10	3.742+02	1.282+00	2.541+00	1.906+09	8.047+08	2.150+05	4.652+04
4	1.440+09	4.816-01	1.995+10	3.951+02	1.315+00	2.573+00	2.596+09	1.054+09	2.329+05	5.357+04
5	1.800+09	4.744-01	2.371+10	4.151+02	1.342+00	2.603+00	3.280+09	1.307+09	2.478+05	5.986+04
6	2.160+09	4.682-01	2.732+10	4.346+02	1.366+00	2.630+00	3.958+09	1.561+09	2.607+05	6.557+04
7	2.520+09	4.626-01	3.080+10	4.536+02	1.387+00	2.656+00	4.631+09	1.816+09	2.720+05	7.083+04
8	2.880+09	4.576-01	3.416+10	4.723+02	1.405+00	2.681+00	5.299+09	2.074+09	2.822+05	7.573+04
9	3.240+09	4.531-01	3.743+10	4.907+02	1.422+00	2.705+00	5.963+09	2.332+09	2.914+05	8.034+04
10	3.600+09	4.489-01	4.062+10	5.089+02	1.438+00	2.727+00	6.624+09	2.592+09	3.000+05	8.470+04
11	3.960+09	4.450-01	4.374+10	5.268+02	1.452+00	2.749+00	7.282+09	2.853+09	3.079+05	8.885+04
12	4.320+09	4.414-01	4.679+10	5.446+02	1.466+00	2.769+00	7.938+09	3.114+09	3.153+05	9.281+04
13	4.680+09	4.380-01	4.978+10	5.623+02	1.478+00	2.789+00	8.591+09	3.376+09	3.223+05	9.661+04
14	5.040+09	4.348-01	5.272+10	5.799+02	1.490+00	2.809+00	9.242+09	3.639+09	3.289+05	1.003+05
15	5.400+09	4.318-01	5.561+10	5.973+02	1.501+00	2.828+00	9.891+09	3.903+09	3.351+05	1.038+05
16	5.760+09	4.289-01	5.846+10	6.147+02	1.512+00	2.846+00	1.054+10	4.167+09	3.411+05	1.072+05
17	6.120+09	4.262-01	6.128+10	6.320+02	1.522+00	2.864+00	1.118+10	4.432+09	3.468+05	1.105+05
18	6.480+09	4.236-01	6.405+10	6.492+02	1.532+00	2.881+00	1.183+10	4.697+09	3.523+05	1.137+05
19	6.840+09	4.211-01	6.679+10	6.664+02	1.541+00	2.898+00	1.247+10	4.962+09	3.575+05	1.169+05
20	7.200+09	4.187-01	6.951+10	6.836+02	1.550+00	2.914+00	1.312+10	5.228+09	3.626+05	1.199+05
21	7.560+09	4.164-01	7.219+10	7.006+02	1.558+00	2.930+00	1.376+10	5.494+09	3.675+05	1.229+05
22	7.920+09	4.142-01	7.484+10	7.177+02	1.567+00	2.946+00	1.440+10	5.761+09	3.722+05	1.258+05
23	8.280+09	4.120-01	7.747+10	7.347+02	1.575+00	2.961+00	1.504+10	6.027+09	3.768+05	1.286+05
24	8.640+09	4.100-01	8.008+10	7.517+02	1.582+00	2.976+00	1.568+10	6.294+09	3.813+05	1.314+05
25	9.000+09	4.080-01	8.266+10	7.687+02	1.590+00	2.991+00	1.632+10	6.561+09	3.856+05	1.341+05
26	9.360+09	4.061-01	8.522+10	7.856+02	1.597+00	3.006+00	1.695+10	6.829+09	3.898+05	1.367+05
27	9.720+09	4.042-01	8.776+10	8.025+02	1.604+00	3.020+00	1.759+10	7.096+09	3.939+05	1.394+05
28	1.008+10	4.024-01	9.028+10	8.195+02	1.611+00	3.034+00	1.823+10	7.364+09	3.979+05	1.419+05
29	1.044+10	4.007-01	9.278+10	8.364+02	1.617+00	3.048+00	1.887+10	7.631+09	4.018+05	1.444+05
30	1.080+10	3.990-01	9.526+10	8.532+02	1.624+00	3.061+00	1.950+10	7.899+09	4.056+05	1.469+05
31	1.116+10	3.973-01	9.773+10	8.701+02	1.630+00	3.075+00	2.014+10	8.167+09	4.093+05	1.493+05
32	1.152+10	3.957-01	1.002+11	8.870+02	1.636+00	3.088+00	2.077+10	8.435+09	4.130+05	1.517+05
33	1.188+10	3.941-01	1.026+11	9.039+02	1.642+00	3.101+00	2.141+10	8.703+09	4.166+05	1.541+05
34	1.224+10	3.926-01	1.050+11	9.207+02	1.648+00	3.113+00	2.205+10	8.971+09	4.201+05	1.564+05
35	1.260+10	3.911-01	1.074+11	9.376+02	1.654+00	3.126+00	2.268+10	9.240+09	4.235+05	1.587+05
36	1.296+10	3.896-01	1.098+11	9.545+02	1.659+00	3.138+00	2.332+10	9.508+09	4.269+05	1.610+05
37	1.332+10	3.882-01	1.122+11	9.713+02	1.665+00	3.150+00	2.395+10	9.776+09	4.302+05	1.632+05
38	1.368+10	3.868-01	1.146+11	9.882+02	1.670+00	3.162+00	2.459+10	1.004+10	4.334+05	1.654+05
39	1.404+10	3.855-01	1.169+11	1.005+03	1.676+00	3.174+00	2.522+10	1.031+10	4.366+05	1.675+05
40	1.440+10	3.841-01	1.193+11	1.022+03	1.681+00	3.186+00	2.586+10	1.058+10	4.397+05	1.697+05
41	1.476+10	3.828-01	1.216+11	1.039+03	1.686+00	3.198+00	2.649+10	1.085+10	4.428+05	1.718+05
42	1.512+10	3.816-01	1.239+11	1.056+03	1.691+00	3.209+00	2.713+10	1.112+10	4.459+05	1.739+05
43	1.548+10	3.803-01	1.263+11	1.073+03	1.696+00	3.220+00	2.776+10	1.139+10	4.489+05	1.759+05
44	1.584+10	3.791-01	1.286+11	1.089+03	1.701+00	3.232+00	2.840+10	1.165+10	4.518+05	1.780+05
45	1.620+10	3.779-01	1.308+11	1.106+03	1.705+00	3.243+00	2.903+10	1.192+10	4.547+05	1.800+05
46	1.656+10	3.767-01	1.331+11	1.123+03	1.710+00	3.254+00	2.967+10	1.219+10	4.576+05	1.820+05
47	1.692+10	3.756-01	1.354+11	1.140+03	1.714+00	3.264+00	3.030+10	1.246+10	4.604+05	1.840+05
48	1.728+10	3.744-01	1.377+11	1.157+03	1.719+00	3.275+00	3.094+10	1.273+10	4.632+05	1.859+05
49	1.764+10	3.733-01	1.399+11	1.174+03	1.723+00	3.286+00	3.157+10	1.300+10	4.659+05	1.878+05

TABLE B.5 (Continued)

25 Percent Water, 10 Percent Porosity Mixture (Continued)

50	1.800+10	3.722-01	1.422+11	1.191+03	1.728+00	3.296+00	3.221+10	1.326+10	4.686+05	1.897+05
51	1.836+10	3.712-01	1.444+11	1.208+03	1.732+00	3.306+00	3.284+10	1.353+10	4.713+05	1.916+05
52	1.872+10	3.701-01	1.456+11	1.225+03	1.736+00	3.317+00	3.348+10	1.380+10	4.740+05	1.935+05
53	1.908+10	3.691-01	1.489+11	1.242+03	1.740+00	3.327+00	3.412+10	1.407+10	4.766+05	1.954+05
54	1.944+10	3.681-01	1.511+11	1.259+03	1.744+00	3.337+00	3.475+10	1.434+10	4.792+05	1.972+05
55	1.980+10	3.671-01	1.533+11	1.276+03	1.748+00	3.347+00	3.539+10	1.460+10	4.817+05	1.990+05
56	2.016+10	3.661-01	1.555+11	1.293+03	1.752+00	3.357+00	3.603+10	1.487+10	4.842+05	2.008+05
57	2.052+10	3.651-01	1.577+11	1.310+03	1.756+00	3.367+00	3.666+10	1.514+10	4.867+05	2.026+05
58	2.088+10	3.642-01	1.598+11	1.327+03	1.760+00	3.376+00	3.730+10	1.541+10	4.892+05	2.044+05
59	2.124+10	3.632-01	1.620+11	1.344+03	1.764+00	3.386+00	3.794+10	1.567+10	4.916+05	2.061+05
60	2.160+10	3.623-01	1.642+11	1.361+03	1.768+00	3.395+00	3.857+10	1.594+10	4.940+05	2.079+05
61	2.196+10	3.614-01	1.664+11	1.378+03	1.772+00	3.405+00	3.921+10	1.621+10	4.964+05	2.096+05
62	2.232+10	3.605-01	1.685+11	1.395+03	1.775+00	3.414+00	3.985+10	1.648+10	4.988+05	2.113+05
63	2.268+10	3.596-01	1.707+11	1.412+03	1.779+00	3.424+00	4.048+10	1.675+10	5.011+05	2.130+05
64	2.304+10	3.587-01	1.728+11	1.429+03	1.782+00	3.433+00	4.112+10	1.701+10	5.035+05	2.147+05
65	2.340+10	3.579-01	1.750+11	1.446+03	1.786+00	3.442+00	4.176+10	1.728+10	5.058+05	2.164+05
66	2.376+10	3.570-01	1.771+11	1.463+03	1.790+00	3.451+00	4.240+10	1.755+10	5.080+05	2.180+05
67	2.412+10	3.562-01	1.792+11	1.480+03	1.793+00	3.460+00	4.304+10	1.781+10	5.103+05	2.197+05
68	2.448+10	3.554-01	1.813+11	1.497+03	1.796+00	3.469+00	4.368+10	1.808+10	5.125+05	2.213+05
69	2.484+10	3.546-01	1.835+11	1.514+03	1.800+00	3.478+00	4.432+10	1.835+10	5.147+05	2.230+05
70	2.520+10	3.538-01	1.856+11	1.531+03	1.803+00	3.486+00	4.495+10	1.862+10	5.169+05	2.246+05
71	2.556+10	3.530-01	1.877+11	1.548+03	1.807+00	3.495+00	4.559+10	1.888+10	5.191+05	2.262+05
72	2.592+10	3.522-01	1.898+11	1.566+03	1.810+00	3.504+00	4.623+10	1.915+10	5.212+05	2.278+05
73	2.628+10	3.514-01	1.919+11	1.583+03	1.813+00	3.512+00	4.687+10	1.942+10	5.234+05	2.293+05
74	2.664+10	3.507-01	1.940+11	1.600+03	1.816+00	3.521+00	4.751+10	1.968+10	5.255+05	2.309+05
75	2.700+10	3.499-01	1.961+11	1.617+03	1.819+00	3.529+00	4.815+10	1.995+10	5.276+05	2.325+05
76	2.736+10	3.492-01	1.981+11	1.634+03	1.823+00	3.538+00	4.879+10	2.022+10	5.297+05	2.340+05
77	2.772+10	3.484-01	2.002+11	1.651+03	1.826+00	3.546+00	4.943+10	2.048+10	5.317+05	2.355+05
78	2.808+10	3.477-01	2.023+11	1.669+03	1.829+00	3.554+00	5.008+10	2.075+10	5.338+05	2.371+05
79	2.844+10	3.470-01	2.044+11	1.686+03	1.832+00	3.563+00	5.072+10	2.101+10	5.358+05	2.386+05
80	2.880+10	3.463-01	2.064+11	1.703+03	1.835+00	3.571+00	5.136+10	2.128+10	5.378+05	2.401+05
81	2.916+10	3.456-01	2.085+11	1.720+03	1.838+00	3.579+00	5.200+10	2.155+10	5.398+05	2.416+05
82	2.952+10	3.449-01	2.106+11	1.738+03	1.841+00	3.587+00	5.264+10	2.181+10	5.418+05	2.431+05
83	2.988+10	3.442-01	2.126+11	1.755+03	1.844+00	3.595+00	5.328+10	2.208+10	5.438+05	2.446+05
84	3.024+10	3.435-01	2.147+11	1.772+03	1.847+00	3.603+00	5.393+10	2.234+10	5.457+05	2.460+05
85	3.060+10	3.429-01	2.167+11	1.789+03	1.850+00	3.611+00	5.457+10	2.261+10	5.477+05	2.475+05
86	3.096+10	3.422-01	2.187+11	1.807+03	1.853+00	3.619+00	5.521+10	2.288+10	5.496+05	2.489+05
87	3.132+10	3.415-01	2.208+11	1.824+03	1.855+00	3.627+00	5.586+10	2.314+10	5.515+05	2.504+05
88	3.168+10	3.409-01	2.228+11	1.841+03	1.858+00	3.634+00	5.650+10	2.341+10	5.534+05	2.518+05
89	3.204+10	3.403-01	2.248+11	1.859+03	1.861+00	3.642+00	5.714+10	2.367+10	5.553+05	2.532+05
90	3.240+10	3.396-01	2.269+11	1.876+03	1.864+00	3.650+00	5.779+10	2.394+10	5.572+05	2.547+05
91	3.276+10	3.390-01	2.289+11	1.893+03	1.867+00	3.658+00	5.843+10	2.420+10	5.591+05	2.561+05
92	3.312+10	3.384-01	2.309+11	1.911+03	1.869+00	3.665+00	5.907+10	2.447+10	5.609+05	2.575+05
93	3.348+10	3.378-01	2.329+11	1.928+03	1.872+00	3.673+00	5.972+10	2.473+10	5.628+05	2.589+05
94	3.384+10	3.372-01	2.349+11	1.945+03	1.875+00	3.680+00	6.036+10	2.500+10	5.646+05	2.603+05
95	3.420+10	3.366-01	2.369+11	1.963+03	1.877+00	3.688+00	6.101+10	2.526+10	5.664+05	2.616+05
96	3.456+10	3.360-01	2.389+11	1.980+03	1.880+00	3.695+00	6.165+10	2.553+10	5.682+05	2.630+05
97	3.492+10	3.354-01	2.409+11	1.998+03	1.883+00	3.702+00	6.230+10	2.579+10	5.700+05	2.644+05
98	3.528+10	3.348-01	2.429+11	2.015+03	1.885+00	3.710+00	6.295+10	2.606+10	5.718+05	2.658+05
99	3.564+10	3.342-01	2.449+11	2.033+03	1.888+00	3.717+00	6.359+10	2.632+10	5.736+05	2.671+05
100	3.600+10	3.336-01	2.469+11	2.050+03	1.890+00	3.724+00	6.424+10	2.659+10	5.753+05	2.685+05
101	3.636+10	3.331-01	2.489+11	2.067+03	1.893+00	3.732+00	6.489+10	2.685+10	5.771+05	2.698+05
102	3.672+10	3.325-01	2.509+11	2.085+03	1.895+00	3.739+00	6.553+10	2.712+10	5.788+05	2.711+05
103	3.708+10	3.319-01	2.529+11	2.102+03	1.898+00	3.746+00	6.618+10	2.738+10	5.805+05	2.724+05

TABLE B.5 (Continued)

25 Percent Water, 10 Percent Porosity Mixture (Continued)

104	3.744+10	3.314-01	2.548+11	2.120+03	1.900+00	3.753+00	6.683+10	2.764+10	5.823+05	2.738+05
105	3.780+10	3.309-01	2.568+11	2.137+03	1.903+00	3.760+00	6.747+10	2.791+10	5.840+05	2.751+05
106	3.816+10	3.303-01	2.588+11	2.155+03	1.905+00	3.767+00	6.812+10	2.817+10	5.857+05	2.764+05
107	3.852+10	3.298-01	2.608+11	2.172+03	1.908+00	3.774+00	6.877+10	2.844+10	5.874+05	2.777+05
108	3.888+10	3.292-01	2.627+11	2.190+03	1.910+00	3.781+00	6.942+10	2.870+10	5.890+05	2.790+05
109	3.924+10	3.287-01	2.647+11	2.208+03	1.913+00	3.788+00	7.007+10	2.896+10	5.907+05	2.803+05
110	3.960+10	3.282-01	2.666+11	2.225+03	1.915+00	3.795+00	7.072+10	2.923+10	5.924+05	2.816+05
111	3.996+10	3.277-01	2.686+11	2.243+03	1.917+00	3.802+00	7.137+10	2.949+10	5.940+05	2.828+05
112	4.032+10	3.272-01	2.706+11	2.260+03	1.920+00	3.808+00	7.202+10	2.975+10	5.957+05	2.841+05
113	4.068+10	3.267-01	2.725+11	2.278+03	1.922+00	3.815+00	7.267+10	3.002+10	5.973+05	2.854+05
114	4.104+10	3.261-01	2.745+11	2.296+03	1.924+00	3.822+00	7.332+10	3.028+10	5.989+05	2.866+05
115	4.140+10	3.256-01	2.764+11	2.313+03	1.927+00	3.829+00	7.397+10	3.054+10	6.006+05	2.879+05
116	4.176+10	3.252-01	2.784+11	2.331+03	1.929+00	3.835+00	7.462+10	3.081+10	6.022+05	2.891+05
117	4.212+10	3.247-01	2.803+11	2.348+03	1.931+00	3.842+00	7.527+10	3.107+10	6.038+05	2.904+05
118	4.248+10	3.242-01	2.822+11	2.366+03	1.933+00	3.849+00	7.592+10	3.133+10	6.054+05	2.916+05
119	4.284+10	3.237-01	2.842+11	2.384+03	1.936+00	3.855+00	7.657+10	3.160+10	6.069+05	2.929+05
120	4.320+10	3.232-01	2.861+11	2.401+03	1.938+00	3.862+00	7.722+10	3.186+10	6.085+05	2.941+05
121	4.356+10	3.227-01	2.880+11	2.419+03	1.940+00	3.868+00	7.788+10	3.212+10	6.101+05	2.953+05
122	4.392+10	3.223-01	2.900+11	2.437+03	1.942+00	3.875+00	7.853+10	3.238+10	6.117+05	2.965+05
123	4.428+10	3.218-01	2.919+11	2.455+03	1.945+00	3.881+00	7.918+10	3.265+10	6.132+05	2.977+05
124	4.464+10	3.213-01	2.938+11	2.472+03	1.947+00	3.888+00	7.983+10	3.291+10	6.148+05	2.989+05
125	4.500+10	3.209-01	2.957+11	2.490+03	1.949+00	3.894+00	8.049+10	3.317+10	6.163+05	3.002+05
126	4.536+10	3.204-01	2.977+11	2.508+03	1.951+00	3.901+00	8.114+10	3.343+10	6.178+05	3.014+05
127	4.572+10	3.200-01	2.996+11	2.525+03	1.953+00	3.907+00	8.179+10	3.370+10	6.194+05	3.025+05
128	4.608+10	3.195-01	3.015+11	2.543+03	1.955+00	3.913+00	8.245+10	3.396+10	6.209+05	3.037+05

TABLE B.5 (Continued)

25 PERCENT WATER, 5 PERCENT POROSITY MIXTURE

K	AIR	TVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	5.094-01	8.657+09	3.282+02	1.209+00	2.479+00	4.720+08	3.227+08	1.912+05	2.683+04
2	7.200+08	4.921-01	1.434+10	3.506+02	1.280+00	2.527+00	1.137+09	5.808+08	2.239+05	3.796+04
3	1.080+09	4.807-01	1.923+10	3.707+02	1.326+00	2.568+00	1.810+09	8.368+08	2.457+05	4.639+04
4	1.440+09	4.722-01	2.385+10	3.894+02	1.356+00	2.605+00	2.463+09	1.099+09	2.638+05	5.357+04
5	1.800+09	4.648-01	2.804+10	4.075+02	1.385+00	2.638+00	3.122+09	1.359+09	2.776+05	5.985+04
6	2.160+09	4.582-01	3.214+10	4.249+02	1.411+00	2.668+00	3.772+09	1.623+09	2.898+05	6.572+04
7	2.520+09	4.527-01	3.588+10	4.422+02	1.433+00	2.696+00	4.424+09	1.885+09	3.001+05	7.083+04
8	2.880+09	4.477-01	3.956+10	4.590+02	1.452+00	2.722+00	5.070+09	2.150+09	3.096+05	7.572+04
9	3.240+09	4.430-01	4.314+10	4.756+02	1.471+00	2.747+00	5.713+09	2.416+09	3.183+05	8.033+04
10	3.600+09	4.388-01	4.662+10	4.920+02	1.487+00	2.771+00	6.354+09	2.682+09	3.262+05	8.469+04
11	3.960+09	4.348-01	5.002+10	5.082+02	1.503+00	2.794+00	6.992+09	2.949+09	3.337+05	8.883+04
12	4.320+09	4.311-01	5.334+10	5.243+02	1.517+00	2.816+00	7.628+09	3.217+09	3.406+05	9.280+04
13	4.680+09	4.277-01	5.659+10	5.402+02	1.531+00	2.837+00	8.262+09	3.486+09	3.472+05	9.660+04
14	5.040+09	4.244-01	5.978+10	5.561+02	1.543+00	2.857+00	8.895+09	3.755+09	3.534+05	1.003+05
15	5.400+09	4.214-01	6.292+10	5.719+02	1.555+00	2.877+00	9.527+09	4.024+09	3.592+05	1.038+05
16	5.760+09	4.185-01	6.601+10	5.877+02	1.567+00	2.896+00	1.016+10	4.294+09	3.649+05	1.072+05
17	6.120+09	4.157-01	6.905+10	6.034+02	1.578+00	2.915+00	1.079+10	4.564+09	3.703+05	1.105+05
18	6.480+09	4.131-01	7.205+10	6.190+02	1.588+00	2.933+00	1.142+10	4.835+09	3.754+05	1.137+05
19	6.840+09	4.106-01	7.501+10	6.347+02	1.598+00	2.951+00	1.204+10	5.106+09	3.804+05	1.168+05
20	7.200+09	4.082-01	7.794+10	6.503+02	1.608+00	2.968+00	1.267+10	5.377+09	3.852+05	1.199+05
21	7.560+09	4.058-01	8.083+10	6.658+02	1.617+00	2.985+00	1.330+10	5.648+09	3.899+05	1.229+05
22	7.920+09	4.036-01	8.369+10	6.814+02	1.626+00	3.001+00	1.392+10	5.919+09	3.944+05	1.258+05
23	8.280+09	4.015-01	8.652+10	6.970+02	1.635+00	3.018+00	1.455+10	6.191+09	3.987+05	1.286+05
24	8.640+09	3.994-01	8.933+10	7.125+02	1.643+00	3.033+00	1.517+10	6.463+09	4.030+05	1.314+05
25	9.000+09	3.974-01	9.211+10	7.280+02	1.651+00	3.049+00	1.580+10	6.734+09	4.071+05	1.341+05
26	9.360+09	3.955-01	9.487+10	7.435+02	1.659+00	3.064+00	1.642+10	7.006+09	4.111+05	1.367+05
27	9.720+09	3.936-01	9.760+10	7.591+02	1.667+00	3.079+00	1.705+10	7.278+09	4.150+05	1.393+05
28	1.008+10	3.918-01	1.003+11	7.746+02	1.674+00	3.093+00	1.767+10	7.550+09	4.189+05	1.419+05
29	1.044+10	3.901-01	1.030+11	7.901+02	1.681+00	3.108+00	1.829+10	7.822+09	4.226+05	1.444+05
30	1.080+10	3.883-01	1.057+11	8.056+02	1.688+00	3.122+00	1.892+10	8.095+09	4.262+05	1.469+05
31	1.116+10	3.867-01	1.083+11	8.212+02	1.695+00	3.136+00	1.954+10	8.367+09	4.298+05	1.493+05
32	1.152+10	3.851-01	1.110+11	8.367+02	1.701+00	3.149+00	2.016+10	8.639+09	4.333+05	1.517+05
33	1.188+10	3.835-01	1.136+11	8.523+02	1.708+00	3.163+00	2.079+10	8.911+09	4.367+05	1.541+05
34	1.224+10	3.820-01	1.162+11	8.678+02	1.714+00	3.176+00	2.141+10	9.184+09	4.401+05	1.564+05
35	1.260+10	3.805-01	1.188+11	8.834+02	1.720+00	3.189+00	2.203+10	9.456+09	4.434+05	1.587+05
36	1.296+10	3.790-01	1.213+11	8.990+02	1.726+00	3.202+00	2.266+10	9.728+09	4.467+05	1.610+05
37	1.332+10	3.776-01	1.239+11	9.146+02	1.732+00	3.215+00	2.328+10	1.000+10	4.498+05	1.632+05
38	1.368+10	3.762-01	1.264+11	9.302+02	1.738+00	3.227+00	2.390+10	1.027+10	4.530+05	1.654+05
39	1.404+10	3.749-01	1.289+11	9.458+02	1.744+00	3.240+00	2.453+10	1.054+10	4.561+05	1.675+05
40	1.440+10	3.736-01	1.315+11	9.615+02	1.749+00	3.252+00	2.515+10	1.082+10	4.591+05	1.697+05
41	1.476+10	3.723-01	1.340+11	9.771+02	1.755+00	3.264+00	2.577+10	1.109+10	4.621+05	1.718+05
42	1.512+10	3.710-01	1.364+11	9.928+02	1.760+00	3.276+00	2.640+10	1.136+10	4.650+05	1.739+05
43	1.548+10	3.698-01	1.389+11	1.008+03	1.765+00	3.2[illegible]8+00	2.702+10	1.163+10	4.679+05	1.759+05
44	1.584+10	3.685-01	1.414+11	1.024+03	1.770+00	3.299+00	2.764+10	1.191+10	4.708+05	1.780+05
45	1.620+10	3.674-01	1.438+11	1.040+03	1.775+00	3.311+00	2.827+10	1.218+10	4.736+05	1.800+05
46	1.656+10	3.662-01	1.463+11	1.056+03	1.780+00	3.322+00	2.889+10	1.245+10	4.763+05	1.820+05
47	1.692+10	3.650-01	1.487+11	1.071+03	1.785+00	3.333+00	2.952+10	1.272+10	4.791+05	1.840+05
48	1.728+10	3.639-01	1.511+11	1.087+03	1.790+00	3.344+00	3.014+10	1.299+10	4.818+05	1.859+05
49	1.764+10	3.628-01	1.536+11	1.103+03	1.795+00	3.355+00	3.077+10	1.326+10	4.845+05	1.878+05

TABLE B.5 (Continued)

25 Percent Water, 5 Percent Porosity Mixture (Continued)

50	1.800+10	3.617-01	1.560+11	1.119+03	1.799+00	3.366+00	3.139+10	1.354+10	4.871+05	1.897+05
51	1.836+10	3.607-01	1.584+11	1.134+03	1.804+00	3.377+00	3.202+10	1.381+10	4.897+05	1.916+05
52	1.872+10	3.596-01	1.607+11	1.150+03	1.808+00	3.388+00	3.264+10	1.408+10	4.923+05	1.935+05
53	1.908+10	3.586-01	1.631+11	1.166+03	1.813+00	3.398+00	3.327+10	1.435+10	4.948+05	1.954+05
54	1.944+10	3.576-01	1.655+11	1.182+03	1.817+00	3.409+00	3.389+10	1.462+10	4.973+05	1.972+05
55	1.980+10	3.566-01	1.679+11	1.198+03	1.821+00	3.419+00	3.452+10	1.489+10	4.998+05	1.990+05
56	2.016+10	3.556-01	1.702+11	1.214+03	1.826+00	3.429+00	3.514+10	1.517+10	5.022+05	2.008+05
57	2.052+10	3.547-01	1.726+11	1.230+03	1.830+00	3.439+00	3.577+10	1.544+10	5.047+05	2.026+05
58	2.088+10	3.537-01	1.749+11	1.246+03	1.834+00	3.449+00	3.640+10	1.571+10	5.071+05	2.044+05
59	2.124+10	3.528-01	1.772+11	1.262+03	1.838+00	3.459+00	3.702+10	1.598+10	5.095+05	2.061+05
60	2.160+10	3.519-01	1.795+11	1.277+03	1.842+00	3.469+00	3.765+10	1.625+10	5.118+05	2.079+05
61	2.196+10	3.510-01	1.819+11	1.293+03	1.846+00	3.479+00	3.828+10	1.652+10	5.141+05	2.096+05
62	2.232+10	3.501-01	1.842+11	1.309+03	1.850+00	3.489+00	3.891+10	1.679+10	5.165+05	2.113+05
63	2.268+10	3.492-01	1.865+11	1.325+03	1.854+00	3.498+00	3.953+10	1.706+10	5.187+05	2.130+05
64	2.304+10	3.484-01	1.888+11	1.341+03	1.858+00	3.508+00	4.016+10	1.733+10	5.210+05	2.147+05
65	2.340+10	3.475-01	1.911+11	1.358+03	1.861+00	3.517+00	4.079+10	1.760+10	5.232+05	2.164+05
66	2.376+10	3.467-01	1.933+11	1.374+03	1.865+00	3.527+00	4.142+10	1.787+10	5.255+05	2.180+05
	2.412+10	3.459-01	1.956+11	1.390+03	1.869+00	3.536+00	4.205+10	1.814+10	5.277+05	2.197+05
68	2.448+10	3.451-01	1.979+11	1.406+03	1.872+00	3.545+00	4.268+10	1.841+10	5.298+05	2.213+05
69	2.484+10	3.443-01	2.002+11	1.422+03	1.876+00	3.555+00	4.331+10	1.868+10	5.320+05	2.229+05
70	2.520+10	3.435-01	2.024+11	1.438+03	1.879+00	3.564+00	4.394+10	1.895+10	5.342+05	2.245+05
71	2.556+10	3.427-01	2.047+11	1.454+03	1.883+00	3.573+00	4.457+10	1.922+10	5.363+05	2.261+05
72	2.592+10	3.419-01	2.069+11	1.470+03	1.886+00	3.582+00	4.520+10	1.949+10	5.384+05	2.277+05
73	2.628+10	3.412-01	2.092+11	1.486+03	1.890+00	3.591+00	4.583+10	1.976+10	5.405+05	2.293+05
74	2.664+10	3.404-01	2.114+11	1.503+03	1.893+00	3.600+00	4.646+10	2.003+10	5.426+05	2.309+05
75	2.700+10	3.397-01	2.136+11	1.519+03	1.897+00	3.608+00	4.709+10	2.030+10	5.446+05	2.324+05
76	2.736+10	3.389-01	2.158+11	1.535+03	1.900+00	3.617+00	4.772+10	2.057+10	5.467+05	2.340+05
77	2.772+10	3.382-01	2.181+11	1.551+03	1.903+00	3.626+00	4.835+10	2.084+10	5.487+05	2.355+05
78	2.808+10	3.375-01	2.203+11	1.568+03	1.906+00	3.634+00	4.898+10	2.111+10	5.507+05	2.370+05
79	2.844+10	3.368-01	2.225+11	1.584+03	1.910+00	3.643+00	4.961+10	2.138+10	5.527+05	2.386+05
80	2.880+10	3.361-01	2.247+11	1.600+03	1.913+00	3.651+00	5.025+10	2.165+10	5.547+05	2.401+05
81	2.916+10	3.354-01	2.269+11	1.6[illegible]+03	1.916+00	3.660+00	5.088+10	2.192+10	5.566+05	2.416+05
82	2.952+10	3.347-01	2.291+11	1.633+03	1.919+00	3.668+00	5.151+10	2.219+10	5.586+05	2.431+05
83	2.988+10	3.341-01	2.313+11	1.649+03	1.922+00	3.676+00	5.215+10	2.246+10	5.605+05	2.445+05
84	3.024+10	3.334-01	2.335+11	1.666+03	1.925+00	3.685+00	5.278+10	2.273+10	5.624+05	2.460+05
85	3.060+10	3.327-01	2.357+11	1.682+03	1.928+00	3.693+00	5.341+10	2.300+10	5.643+05	2.475+05
86	3.096+10	3.321-01	2.378+11	1.698+03	1.931+00	3.701+00	5.405+10	2.326+10	5.662+05	2.489+05
87	3.132+10	3.314-01	2.400+11	1.715+03	1.934+00	3.709+00	5.468+10	2.353+10	5.681+05	2.504+05
88	3.168+10	3.308-01	2.422+11	1.731+03	1.937+00	3.717+00	5.532+10	2.380+10	5.700+05	2.518+05
89	3.204+10	3.302-01	2.444+11	1.748+03	1.940+00	3.725+00	5.595+10	2.407+10	5.718+05	2.532+05
90	3.240+10	3.296-01	2.465+11	1.764+03	1.943+00	3.733+00	5.659+10	2.434+10	5.737+05	2.546+05
91	3.276+10	3.289-01	2.487+11	1.780+03	1.946+00	3.741+00	5.722+10	2.461+10	5.755+05	2.560+05
92	3.312+10	3.283-01	2.508+11	1.797+03	1.949+00	3.749+00	5.786+10	2.487+10	5.773+05	2.575+05
93	3.348+10	3.277-01	2.530+11	1.813+03	1.952+00	3.757+00	5.849+10	2.514+10	5.792+05	2.588+05
94	3.384+10	3.271-01	2.551+11	1.830+03	1.954+00	3.765+00	5.913+10	2.541+10	5.810+05	2.602+05
95	3.420+10	3.265-01	2.573+11	1.846+03	1.957+00	3.772+00	5.977+10	2.568+10	5.827+05	2.616+05
96	3.456+10	3.260-01	2.594+11	1.863+03	1.960+00	3.780+00	6.040+10	2.595+10	5.845+05	2.630+05
97	3.492+10	3.254-01	2.616+11	1.880+03	1.963+00	3.788+00	6.104+10	2.621+10	5.863+05	2.644+05
98	3.528+10	3.248-01	2.637+11	1.896+03	1.965+00	3.795+00	6.168+10	2.648+10	5.880+05	2.657+05
99	3.564+10	3.242-01	2.658+11	1.913+03	1.968+00	3.803+00	6.232+10	2.675+10	5.898+05	2.671+05
100	3.600+10	3.237-01	2.679+11	1.929+03	1.971+00	3.810+00	6.296+10	2.701+10	5.915+05	2.684+05
101	3.636+10	3.23[illegible]-01	2.701+11	1.946+03	1.974+00	3.818+00	6.359+10	2.728+10	5.932+05	2.698+05
102	3.672+10	3.226-01	2.722+11	1.963+03	1.976+00	3.825+00	6.423+10	2.755+10	5.950+05	2.711+05
103	3.708+10	3.220-01	2.743+11	1.979+03	1.979+00	3.833+00	6.487+10	2.782+10	5.967+05	2.724+05

TABLE B.5 (Continued)

25 Percent Water, 5 Percent Porosity Mixture (Continued)

104	3.744+10	3.215-01	2.764+11	1.996+03	1.981+00	3.840+00	6.551+10	2.808+10	5.984+05	2.737+05
105	3.780+10	3.210-01	2.785+11	2.013+03	1.984+00	3.847+00	6.615+10	2.835+10	6.000+05	2.750+05
106	3.816+10	3.204-01	2.806+11	2.029+03	1.986+00	3.855+00	6.679+10	2.862+10	6.017+05	2.764+05
107	3.852+10	3.199-01	2.827+11	2.046+03	1.989+00	3.862+00	6.743+10	2.888+10	6.034+05	2.777+05
108	3.888+10	3.194-01	2.848+11	2.063+03	1.992+00	3.869+00	6.807+10	2.915+10	6.050+05	2.789+05
109	3.924+10	3.189-01	2.869+11	2.079+03	1.994+00	3.876+00	6.871+10	2.942+10	6.067+05	2.802+05
110	3.960+10	3.183-01	2.890+11	2.096+03	1.996+00	3.883+00	6.935+10	2.968+10	6.083+05	2.815+05
111	3.996+10	3.178-01	2.911+11	2.113+03	1.999+00	3.891+00	7.000+10	2.995+10	6.100+05	2.828+05
112	4.032+10	3.173-01	2.932+11	2.130+03	2.001+00	3.898+00	7.064+10	3.021+10	6.116+05	2.841+05
113	4.068+10	3.168-01	2.953+11	2.147+03	2.004+00	3.905+00	7.128+10	3.048+10	6.132+05	2.853+05
114	4.104+10	3.163-01	2.973+11	2.163+03	2.006+00	3.912+00	7.192+10	3.075+10	6.148+05	2.866+05
115	4.140+10	3.159-01	2.994+11	2.180+03	2.009+00	3.919+00	7.257+10	3.101+10	6.164+05	2.878+05
116	4.176+10	3.154-01	3.015+11	2.197+03	2.011+00	3.926+00	7.321+10	3.128+10	6.180+05	2.891+05

TABLE B.5 (Continued)

100 PERCENT WATER, 20 PERCENT POROSITY MIXTURE

K	AIX	TVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	9.311-01	2.244+09	3.190+02	1.074+00	2.400+00	3.600+08	3.600+08	1.047+05	2.684+04
2	7.200+08	8.965-01	4.046+09	3.292+02	1.115+00	2.400+00	7.200+08	7.200+08	1.336+05	3.794+04
3	1.080+09	8.735-01	5.692+09	3.427+02	1.145+00	2.400+00	1.080+09	1.080+09	1.535+05	4.643+04
4	1.440+09	8.560-01	7.266+09	3.554+02	1.168+00	2.400+00	1.440+09	1.440+09	1.696+05	5.366+04
5	1.800+09	8.418-01	8.804+09	3.677+02	1.188+00	2.400+00	1.800+09	1.800+09	1.834+05	6.012+04
6	2.160+09	8.304-01	1.025+10	3.796+02	1.204+00	2.400+00	2.160+09	2.160+09	1.952+05	6.577+04
7	2.520+09	8.205-01	1.168+10	3.914+02	1.219+00	2.400+00	2.520+09	2.520+09	2.059+05	7.100+04
8	2.880+09	8.118-01	1.308+10	4.029+02	1.232+00	2.400+00	2.880+09	2.880+09	2.158+05	7.589+04
9	3.240+09	8.041-01	1.445+10	4.143+02	1.244+00	2.400+00	3.240+09	3.240+09	2.249+05	8.048+04
10	3.600+09	7.972-01	1.581+10	4.256+02	1.254+00	2.400+00	3.600+09	3.600+09	2.334+05	8.483+04
11	3.960+09	7.908-01	1.715+10	4.369+02	1.264+00	2.400+00	3.960+09	3.960+09	2.414+05	8.896+04
12	4.320+09	7.851-01	1.848+10	4.480+02	1.274+00	2.400+00	4.320+09	4.320+09	2.491+05	9.292+04
13	4.680+09	7.797-01	1.979+10	4.591+02	1.283+00	2.400+00	4.680+09	4.680+09	2.563+05	9.671+04
14	5.040+09	7.748-01	2.110+10	4.701+02	1.291+00	2.400+00	5.040+09	5.040+09	2.632+05	1.004+05
15	5.400+09	7.701-01	2.239+10	4.811+02	1.298+00	2.400+00	5.400+09	5.400+09	2.699+05	1.039+05
16	5.760+09	7.658-01	2.367+10	4.921+02	1.306+00	2.400+00	5.760+09	5.760+09	2.762+05	1.073+05
17	6.120+09	7.617-01	2.494+10	5.030+02	1.313+00	2.400+00	6.120+09	6.120+09	2.824+05	1.106+05
18	6.480+09	7.579-01	2.620+10	5.139+02	1.319+00	2.400+00	6.480+09	6.480+09	2.883+05	1.138+05
19	6.840+09	7.543-01	2.746+10	5.248+02	1.326+00	2.400+00	6.840+09	6.840+09	2.940+05	1.169+05
20	7.200+09	7.508-01	2.870+10	5.356+02	1.332+00	2.400+00	7.200+09	7.200+09	2.996+05	1.200+05
21	7.560+09	7.475-01	2.994+10	5.464+02	1.338+00	2.400+00	7.560+09	7.560+09	3.050+05	1.229+05
22	7.920+09	7.444-01	3.118+10	5.572+02	1.343+00	2.400+00	7.920+09	7.920+09	3.103+05	1.258+05
23	8.280+09	7.414-01	3.241+10	5.680+02	1.349+00	2.400+00	8.280+09	8.280+09	3.154+05	1.287+05
24	8.640+09	7.386-01	3.363+10	5.787+02	1.354+00	2.400+00	8.640+09	8.640+09	3.204+05	1.314+05
25	9.000+09	7.358-01	3.484+10	5.895+02	1.359+00	2.400+00	9.000+09	9.000+09	3.253+05	1.341+05
26	9.360+09	7.332-01	3.605+10	6.002+02	1.364+00	2.400+00	9.360+09	9.360+09	3.300+05	1.368+05
27	9.720+09	7.306-01	3.726+10	6.109+02	1.369+00	2.400+00	9.720+09	9.720+09	3.347+05	1.394+05
28	1.008+10	7.282-01	3.846+10	6.216+02	1.373+00	2.400+00	1.008+10	1.008+10	3.392+05	1.420+05
29	1.044+10	7.258-01	3.965+10	6.323+02	1.378+00	2.400+00	1.044+10	1.044+10	3.437+05	1.445+05
30	1.080+10	7.236-01	4.085+10	6.430+02	1.382+00	2.400+00	1.080+10	1.080+10	3.481+05	1.470+05
31	1.116+10	7.214-01	4.203+10	6.536+02	1.386+00	2.400+00	1.116+10	1.116+10	3.524+05	1.494+05
32	1.152+10	7.192-01	4.322+10	6.643+02	1.390+00	2.400+00	1.152+10	1.152+10	3.566+05	1.518+05
33	1.188+10	7.172-01	4.440+10	6.750+02	1.394+00	2.400+00	1.188+10	1.188+10	3.607+05	1.541+05
34	1.224+10	7.152-01	4.557+10	6.856+02	1.398+00	2.400+00	1.224+10	1.224+10	3.648+05	1.564+05
35	1.260+10	7.132-01	4.674+10	6.963+02	1.402+00	2.400+00	1.260+10	1.260+10	3.688+05	1.587+05
36	1.296+10	7.113-01	4.791+10	7.069+02	1.406+00	2.400+00	1.296+10	1.296+10	3.727+05	1.610+05
37	1.332+10	7.095-01	4.908+10	7.175+02	1.409+00	2.400+00	1.332+10	1.332+10	3.766+05	1.632+05
38	1.368+10	7.077-01	5.024+10	7.282+02	1.413+00	2.400+00	1.368+10	1.368+10	3.804+05	1.654+05
39	1.404+10	7.060-01	5.140+10	7.388+02	1.416+00	2.400+00	1.404+10	1.404+10	3.841+05	1.676+05
40	1.440+10	7.043-01	5.255+10	7.494+02	1.420+00	2.400+00	1.440+10	1.440+10	3.878+05	1.697+05
41	1.476+10	7.026-01	5.370+10	7.600+02	1.423+00	2.400+00	1.476+10	1.476+10	3.914+05	1.718+05
42	1.512+10	7.010-01	5.485+10	7.706+02	1.426+00	2.400+00	1.512+10	1.512+10	3.950+05	1.739+05
43	1.548+10	6.995-01	5.600+10	7.812+02	1.430+00	2.400+00	1.548+10	1.548+10	3.986+05	1.759+05
44	1.584+10	6.979-01	5.714+10	7.918+02	1.433+00	2.400+00	1.584+10	1.584+10	4.021+05	1.780+05
45	1.620+10	6.964-01	5.828+10	8.024+02	1.436+00	2.400+00	1.620+10	1.620+10	4.055+05	1.800+05
46	1.656+10	6.950-01	5.942+10	8.130+02	1.439+00	2.400+00	1.656+10	1.656+10	4.089+05	1.820+05
47	1.692+10	6.935-01	6.056+10	8.236+02	1.442+00	2.400+00	1.692+10	1.692+10	4.123+05	1.839+05
48	1.728+10	6.921-01	6.169+10	8.342+02	1.445+00	2.400+00	1.728+10	1.728+10	4.156+05	1.859+05
49	1.764+10	6.908-01	6.282+10	8.448+02	1.448+00	2.400+00	1.764+10	1.764+10	4.189+05	1.878+05

TABLE B.5 (Continued)

100 Percent Water, 20 Percent Porosity Mixture (Continued)

50	1.800+10	6.894-01	6.395+10	8.553+02	1.451+00	2.400+00	1.800+10	1.800+10	4.221+05	1.897+05
51	1.836+10	6.881-01	6.508+10	8.659+02	1.453+00	2.400+00	1.836+10	1.836+10	4.253+05	1.916+05
52	1.872+10	6.868-01	6.621+10	8.765+02	1.456+00	2.400+00	1.872+10	1.872+10	4.285+05	1.935+05
53	1.908+10	6.855-01	6.733+10	8.871+02	1.459+00	2.400+00	1.908+10	1.908+10	4.316+05	1.953+05
54	1.944+10	6.843-01	6.845+10	8.977+02	1.461+00	2.400+00	1.944+10	1.944+10	4.347+05	1.972+05
55	1.980+10	6.831-01	6.957+10	9.082+02	1.464+00	2.400+00	1.980+10	1.980+10	4.378+05	1.990+05
56	2.016+10	6.819-01	7.068+10	9.188+02	1.467+00	2.400+00	2.016+10	2.016+10	4.408+05	2.008+05
57	2.052+10	6.807-01	7.180+10	9.294+02	1.469+00	2.400+00	2.052+10	2.052+10	4.438+05	2.026+05
58	2.088+10	6.795-01	7.291+10	9.399+02	1.472+00	2.400+00	2.088+10	2.088+10	4.468+05	2.043+05
59	2.124+10	6.784-01	7.402+10	9.505+02	1.474+00	2.400+00	2.124+10	2.124+10	4.497+05	2.061+05
60	2.160+10	6.773-01	7.513+10	9.611+02	1.477+00	2.400+00	2.160+10	2.160+10	4.527+05	2.078+05
61	2.196+10	6.762-01	7.623+10	9.716+02	1.479+00	2.400+00	2.196+10	2.196+10	4.555+05	2.096+05
62	2.232+10	6.751-01	7.734+10	9.822+02	1.481+00	2.400+00	2.232+10	2.232+10	4.584+05	2.113+05
63	2.268+10	6.740-01	7.844+10	9.928+02	1.484+00	2.400+00	2.268+10	2.268+10	4.612+05	2.130+05
64	2.304+10	6.730-01	7.954+10	1.003+03	1.486+00	2.400+00	2.304+10	2.304+10	4.640+05	2.147+05
65	2.340+10	6.720-01	8.064+10	1.014+03	1.488+00	2.400+00	2.340+10	2.340+[illegible]	4.668+05	2.163+05
66	2.376+10	6.710-01	8.174+10	1.024+03	1.490+00	2.400+00	2.376+10	2.376+[illegible]	4.696+05	2.180+05
67	2.412+10	6.700-01	8.284+10	1.035+03	1.493+00	2.400+00	2.412+10	2.412+10	4.723+05	2.196+05
68	2.448+10	6.690-01	8.393+10	1.046+03	1.495+00	2.400+00	2.448+10	2.448+10	4.750+05	2.213+05
69	2.484+10	6.680-01	8.503+10	1.056+03	1.497+00	2.400+00	2.484+10	2.484+10	4.777+05	2.229+05
70	2.520+10	6.670-01	8.612+10	1.067+03	1.499+00	2.400+00	2.520+10	2.520+10	4.804+05	2.245+05
71	2.556+10	6.661-01	8.721+10	1.077+03	1.501+00	2.400+00	2.556+10	2.556+10	4.830+05	2.261+05
72	2.592+10	6.652-01	8.830+10	1.088+03	1.503+00	2.400+00	2.592+10	2.592+10	4.856+05	2.277+05
73	2.628+10	6.643-01	8.939+10	1.098+03	1.505+00	2.400+00	2.628+10	2.628+10	4.882+05	2.293+05
74	2.664+10	6.634-01	9.047+10	1.109+03	1.507+00	2.400+00	2.664+10	2.664+10	4.908+05	2.308+05
75	2.700+10	6.625-01	9.156+10	1.119+03	1.509+00	2.400+00	2.700+10	2.700+10	4.934+05	2.324+05
76	2.736+10	6.616-01	9.264+10	1.130+03	1.511+00	2.400+00	2.736+10	2.736+10	4.959+05	2.339+05
77	2.772+10	6.607-01	9.372+10	1.141+03	1.513+00	2.400+00	2.772+10	2.772+10	4.985+05	2.355+05
78	2.808+10	6.599-01	9.480+10	1.151+03	1.515+00	2.400+00	2.808+10	2.808+10	5.010+05	2.370+05
79	2.844+10	6.590-01	9.588+10	1.162+03	1.517+00	2.400+00	2.844+10	2.844+10	5.034+05	2.385+05
80	2.880+10	6.590-01	9.661+10	1.173+03	1.517+00	2.400+00	2.880+10	2.880+10	5.054+05	2.394+05
81	2.916+10	6.574-01	9.802+10	1.183+03	1.521+00	2.400+00	2.916+10	2.916+10	5.083+05	2.415+05
82	2.952+10	6.574-01	9.876+10	1.194+03	1.521+00	2.400+00	2.952+10	2.952+10	5.102+05	2.424+05
83	2.988+10	6.558-01	1.002+11	1.204+03	1.525+00	2.400+00	2.988+10	2.988+10	5.132+05	2.444+05
84	3.024+10	6.558-01	1.009+11	1.215+03	1.525+00	2.400+00	3.024+10	3.024+10	5.151+05	2.453+05
85	3.060+10	6.542-01	1.023+11	1.225+03	1.529+00	2.400+00	3.060+10	3.060+10	5.180+05	2.474+05
86	3.096+10	6.542-01	1.031+11	1.236+03	1.529+00	2.400+00	3.096+10	3.096+10	5.198+05	2.483+05
87	3.132+10	6.527-01	1.045+11	1.246+03	1.532+00	2.400+00	3.132+10	3.132+10	5.227+05	2.503+05
88	3.168+10	6.527-01	1.052+11	1.257+03	1.532+00	2.400+00	3.168+10	3.168+10	5.245+05	2.512+05
89	3.204+10	6.512-01	1.066+11	1.267+03	1.536+00	2.400+00	3.204+10	3.204+10	5.273+05	2.531+05
90	3.240+10	6.512-01	1.073+11	1.278+03	1.536+00	2.400+00	3.240+10	3.240+10	5.292+05	2.540+05
91	3.276+10	6.497-01	1.087+11	1.288+03	1.539+00	2.400+00	3.276+10	3.276+10	5.319+05	2.560+05
92	3.312+10	6.497-01	1.095+11	1.299+03	1.539+00	2.400+00	3.312+10	3.312+10	5.337+05	2.568+05
93	3.348+10	6.482-01	1.108+11	1.309+03	1.543+00	2.400+00	3.348+10	3.348+10	5.364+05	2.588+05
94	3.384+10	6.482-01	1.116+11	1.320+03	1.543+00	2.400+00	3.384+10	3.384+10	5.383+05	2.596+05
95	3.420+10	6.468-01	1.130+11	1.330+03	1.546+00	2.400+00	3.420+10	3.420+10	5.409+05	2.615+05
96	3.456+10	6.468-01	1.137+11	1.341+03	1.546+00	2.400+00	3.456+10	3.456+10	5.427+05	2.624+05
97	3.492+10	6.455-01	1.151+11	1.351+03	1.549+00	2.400+00	3.492+10	3.492+10	5.453+05	2.643+05
98	3.528+10	6.455-01	1.158+11	1.363+03	1.549+00	2.400+00	3.528+10	3.528+10	5.471+05	2.651+05
99	3.564+10	6.441-01	1.172+11	1.373+03	1.553+00	2.400+00	3.564+10	3.564+10	5.497+05	2.670+05
100	3.600+10	6.441-01	1.179+11	1.384+03	1.553+00	2.400+00	3.600+10	3.600+10	5.515+05	2.678+05
101	3.636+10	6.428-01	1.193+11	1.394+03	1.556+00	2.400+00	3.636+10	3.636+10	5.540+05	2.697+05
102	3.672+10	6.428-01	1.201+11	1.405+03	1.556+00	2.400+00	3.672+10	3.672+10	5.558+05	2.705+05
103	3.708+10	6.415-01	1.214+11	1.415+03	1.559+00	2.400+00	3.708+10	3.708+10	5.583+05	2.723+05

TABLE B.5 (Continued)

100 Percent Water, 20 Percent Porosity Mixture (Continued)

104	3.744+10	6.415-01	1.222+11	1.426+03	1.559+00	2.400+00	3.744+10	3.744+10	5.600+05	2.732+05
105	3.780+10	6.402-01	1.235+11	1.436+03	1.562+00	2.400+00	3.780+10	3.780+10	5.625+05	2.749+05
106	3.816+10	6.402-01	1.243+11	1.447+03	1.562+00	2.400+00	3.816+10	3.816+10	5.642+05	2.758+05
107	3.852+10	6.389-01	1.256+11	1.457+03	1.565+00	2.400+00	3.852+10	3.852+10	5.667+05	2.775+05
108	3.888+10	6.389-01	1.264+11	1.468+03	1.565+00	2.400+00	3.888+10	3.888+10	5.684+05	2.784+05
109	3.924+10	6.377-01	1.277+11	1.478+03	1.568+00	2.400+00	3.924+10	3.924+10	5.708+05	2.801+05
110	3.960+10	6.377-01	1.285+11	1.489+03	1.568+00	2.400+00	3.960+10	3.960+10	5.725+05	2.810+05
111	3.996+10	6.365-01	1.298+11	1.499+03	1.571+00	2.400+00	3.996+10	3.996+10	5.749+05	2.827+05
112	4.032+10	6.365-01	1.305+11	1.510+03	1.571+00	2.400+00	4.032+10	4.032+10	5.766+05	2.835+05
113	4.068+10	6.353-01	1.319+11	1.520+03	1.574+00	2.400+00	4.068+10	4.068+10	5.790+05	2.852+05
114	4.104+10	6.353-01	1.326+11	1.531+03	1.574+00	2.400+00	4.104+10	4.104+10	5.806+05	2.861+05
115	4.140+10	6.342-01	1.339+11	1.541+03	1.577+00	2.400+00	4.140+10	4.140+10	5.830+05	2.877+05
116	4.176+10	6.342-01	1.347+11	1.552+03	1.577+00	2.400+00	4.176+10	4.176+10	5.846+05	2.886+05
117	4.212+10	6.330-01	1.360+11	1.562+03	1.580+00	2.400+00	4.212+10	4.212+10	5.869+05	2.902+05
118	4.248+10	6.330-01	1.368+11	1.573+03	1.580+00	2.400+00	4.248+10	4.248+10	5.886+05	2.910+05
119	4.284+10	6.319-01	1.381+11	1.584+03	1.583+00	2.400+00	4.284+10	4.284+10	5.908+05	2.927+05
120	4.320+10	6.319-01	1.389+11	1.595+03	1.583+00	2.400+00	4.320+10	4.320+10	5.925+05	2.935+05
121	4.356+10	6.308-01	1.402+11	1.605+03	1.585+00	2.400+00	4.356+10	4.356+10	5.947+05	2.952+05
122	4.392+10	6.308-01	1.409+11	1.616+03	1.585+00	2.400+00	4.392+10	4.392+10	5.963+05	2.960+05
123	4.428+10	6.297-01	1.422+11	1.626+03	1.588+00	2.400+00	4.428+10	4.428+10	5.986+05	2.976+05
124	4.464+10	6.297-01	1.430+11	1.637+03	1.588+00	2.400+00	4.464+10	4.464+10	6.002+05	2.984+05
125	4.500+10	6.286-01	1.443+11	1.647+03	1.591+00	2.400+00	4.500+10	4.500+10	6.024+05	3.000+05
126	4.536+10	6.286-01	1.451+11	1.658+03	1.591+00	2.400+00	4.536+10	4.536+10	6.040+05	3.008+05
127	4.572+10	6.275-01	1.464+11	1.668+03	1.594+00	2.400+00	4.572+10	4.572+10	6.061+05	3.024+05
128	4.608+10	6.275-01	1.471+11	1.679+03	1.594+00	2.400+00	4.608+10	4.608+10	6.077+05	3.032+05
129	4.644+10	6.265-01	1.484+11	1.689+03	1.596+00	2.400+00	4.644+10	4.644+10	6.099+05	3.048+05
130	4.680+10	6.265-01	1.492+11	1.700+03	1.596+00	2.400+00	4.680+10	4.680+10	6.115+05	3.055+05
131	4.716+10	6.255-01	1.505+11	1.710+03	1.599+00	2.400+00	4.716+10	4.716+10	6.136+05	3.071+05
132	4.752+10	6.255-01	1.512+11	1.721+03	1.599+00	2.400+00	4.752+10	4.752+10	6.152+05	3.079+05
133	4.788+10	6.255-01	1.520+11	1.732+03	1.599+00	2.400+00	4.788+10	4.788+10	6.167+05	3.087+05
134	4.824+10	6.240-01	1.535+11	1.742+03	1.603+00	2.400+00	4.824+10	4.824+10	6.191+05	3.106+05
135	4.860+10	6.240-01	1.543+11	1.753+03	1.603+00	2.400+00	4.860+10	4.860+10	6.206+05	3.114+05
136	4.896+10	6.240-01	1.551+11	1.764+03	1.603+00	2.400+00	4.896+10	4.896+10	6.222+05	3.122+05
137	4.932+10	6.225-01	1.566+11	1.773+03	1.606+00	2.400+00	4.932+10	4.932+10	6.245+05	3.140+05
138	4.968+10	6.225-01	1.574+11	1.784+03	1.606+00	2.400+00	4.968+10	4.968+10	6.260+05	3.148+05
139	5.004+10	6.225-01	1.582+11	1.795+03	1.606+00	2.400+00	5.004+10	5.004+10	6.276+05	3.156+05
140	5.040+10	6.211-01	1.597+11	1.805+03	1.610+00	2.400+00	5.040+10	5.040+10	6.298+05	3.175+05
141	5.076+10	6.211-01	1.605+11	1.816+03	1.610+00	2.400+00	5.076+10	5.076+10	6.314+05	3.182+05
142	5.112+10	6.211-01	1.612+11	1.827+03	1.610+00	2.400+00	5.112+10	5.112+10	6.329+05	3.190+05
143	5.148+10	6.196-01	1.627+11	1.837+03	1.614+00	2.400+00	5.148+10	5.148+10	6.351+05	3.209+05
144	5.184+10	6.196-01	1.635+11	1.848+03	1.614+00	2.400+00	5.184+10	5.184+10	6.366+05	3.216+05
145	5.220+10	6.196-01	1.643+11	1.859+03	1.614+00	2.400+00	5.220+10	5.220+10	6.381+05	3.224+05
146	5.256+10	6.182-01	1.658+11	1.868+03	1.618+00	2.400+00	5.256+10	5.256+10	6.403+05	3.242+05
147	5.292+10	6.182-01	1.666+11	1.879+03	1.618+00	2.400+00	5.292+10	5.292+10	6.418+05	3.250+05
148	5.328+10	6.182-01	1.673+11	1.890+03	1.618+00	2.400+00	5.328+10	5.328+10	6.433+05	3.257+05
149	5.364+10	6.169-01	1.688+11	1.900+03	1.621+00	2.400+00	5.364+10	5.364+10	6.455+05	3.275+05
150	5.400+10	6.169-01	1.696+11	1.911+03	1.621+00	2.400+00	5.400+10	5.400+10	6.470+05	3.283+05
151	5.436+10	6.169-01	1.704+11	1.922+03	1.621+00	2.400+00	5.436+10	5.436+10	6.485+05	3.290+05
152	5.472+10	6.155-01	1.719+11	1.932+03	1.625+00	2.400+00	5.472+10	5.472+10	6.506+05	3.308+05
153	5.508+10	6.155-01	1.726+11	1.943+03	1.625+00	2.400+00	5.508+10	5.508+10	6.521+05	3.315+05
154	5.544+10	6.155-01	1.734+11	1.954+03	1.625+00	2.400+00	5.544+10	5.544+10	6.535+05	3.323+05
155	5.580+10	6.142-01	1.749+11	1.963+03	1.628+00	2.400+00	5.580+10	5.580+10	6.556+05	3.340+05
156	5.616+10	6.142-01	1.757+11	1.974+03	1.628+00	2.400+00	5.616+10	5.616+10	6.571+05	3.348+05
157	5.652+10	6.142-01	1.765+11	1.985+03	1.628+00	2.400+00	5.652+10	5.652+10	6.585+05	3.355+05

TABLE B.5 (Continued)

100 Percent Water, 20 Percent Porosity Mixture (Continued)

158	5.688+10	6.129-01	1.779+11	1.995+03	1.632+00	2.400+00	5.688+10	5.688+10	6.606+05	3.373+05
159	5.724+10	6.129-01	1.787+11	2.006+03	1.632+00	2.400+00	5.724+10	5.724+10	6.620+05	3.380+05
160	5.760+10	6.129-01	1.795+11	2.017+03	1.632+00	2.400+00	5.760+10	5.760+10	6.635+05	3.387+05
161	5.796+10	6.117-01	1.809+11	2.026+03	1.635+00	2.400+00	5.796+10	5.796+10	6.655+05	3.405+05
162	5.832+10	6.117-01	1.817+11	2.038+03	1.635+00	2.400+00	5.832+10	5.832+10	6.670+05	3.412+05
163	5.868+10	6.117-01	1.825+11	2.049+03	1.635+00	2.400+00	5.868+10	5.868+10	6.684+05	3.419+05
164	5.904+10	6.104-01	1.840+11	2.058+03	1.638+00	2.400+00	5.904+10	5.904+10	6.704+05	3.436+05
165	5.940+10	6.104-01	1.847+11	2.069+03	1.638+00	2.400+00	5.940+10	5.940+10	6.718+05	3.443+05
166	5.976+10	6.104-01	1.855+11	2.080+03	1.638+00	2.400+00	5.976+10	5.976+10	6.732+05	3.451+05
167	6.012+10	6.092-01	1.870+11	2.090+03	1.642+00	2.400+00	6.012+10	6.012+10	6.752+05	3.467+05
168	6.048+10	6.092-01	1.877+11	2.101+03	1.642+00	2.400+00	6.048+10	6.048+10	6.766+05	3.475+05
169	6.084+10	6.092-01	1.885+11	2.112+03	1.642+00	2.400+00	6.084+10	6.084+10	6.780+05	3.482+05
170	6.120+10	6.080-01	1.900+11	2.121+03	1.645+00	2.400+00	6.120+10	6.120+10	6.800+05	3.498+05
171	6.156+10	6.080-01	1.907+11	2.132+03	1.645+00	2.400+00	6.156+10	6.156+10	6.814+05	3.506+05
172	6.192+10	6.080-01	1.915+11	2.143+03	1.645+00	2.400+00	6.192+10	6.192+10	6.828+05	3.513+05
173	6.228+10	6.068-01	1.930+11	2.153+03	1.648+00	2.400+00	6.228+10	6.228+10	6.847+05	3.529+05
174	6.264+10	6.068-01	1.937+11	2.164+03	1.648+00	2.400+00	6.264+10	6.264+10	6.861+05	3.536+05
175	6.300+10	6.068-01	1.945+11	2.175+03	1.648+00	2.400+00	6.300+10	6.300+10	6.875+05	3.543+05
176	6.336+10	6.056-01	1.959+11	2.185+03	1.651+00	2.400+00	6.336+10	6.336+10	6.893+05	3.560+05
177	6.372+10	6.056-01	1.967+11	2.196+03	1.651+00	2.400+00	6.372+10	6.372+10	6.907+05	3.567+05
178	6.408+10	6.056-01	1.975+11	2.207+03	1.651+00	2.400+00	6.408+10	6.408+10	6.921+05	3.574+05
179	6.444+10	6.045-01	1.989+11	2.216+03	1.654+00	2.400+00	6.444+10	6.444+10	6.940+05	3.590+05
180	6.480+10	6.045-01	1.997+11	2.227+03	1.654+00	2.400+00	6.480+10	6.480+10	6.953+05	3.597+05
181	6.516+10	6.045-01	2.005+11	2.238+03	1.654+00	2.400+00	6.516+10	6.516+10	6.967+05	3.604+05
182	6.552+10	6.045-01	2.013+11	2.249+03	1.654+00	2.400+00	6.552+10	6.552+10	6.981+05	3.611+05
183	6.588+10	6.030-01	2.029+11	2.259+03	1.658+00	2.400+00	6.588+10	6.588+10	7.000+05	3.630+05
184	6.624+10	6.030-01	2.037+11	2.270+03	1.658+00	2.400+00	6.624+10	6.624+10	7.014+05	3.637+05
185	6.660+10	6.030-01	2.045+11	2.281+03	1.658+00	2.400+00	6.660+10	6.660+10	7.027+05	3.644+05
186	6.696+10	6.030-01	2.053+11	2.292+03	1.658+00	2.400+00	6.696+10	6.696+10	7.041+05	3.651+05
187	6.732+10	6.015-01	2.069+11	2.301+03	1.663+00	2.400+00	6.732+10	6.732+10	7.060+05	3.669+05
188	6.768+10	6.015-01	2.077+11	2.312+03	1.663+00	2.400+00	6.768+10	6.768+10	7.074+05	3.676+05
189	6.804+10	6.015-01	2.084+11	2.323+03	1.663+00	2.400+00	6.804+10	6.804+10	7.087+05	3.683+05
190	6.840+10	6.015-01	2.092+11	2.334+03	1.663+00	2.400+00	6.840+10	6.840+10	7.101+05	3.690+05
191	6.876+10	6.000-01	2.108+11	2.343+03	1.667+00	2.400+00	6.876+10	6.876+10	7.120+05	3.708+05
192	6.912+10	6.000-01	2.116+11	2.354+03	1.667+00	2.400+00	6.912+10	6.912+10	7.133+05	3.715+05
193	6.948+10	6.000-01	2.124+11	2.365+03	1.667+00	2.400+00	6.948+10	6.948+10	7.146+05	3.722+05
194	6.984+10	6.000-01	2.132+11	2.376+03	1.667+00	2.400+00	6.984+10	6.984+10	7.159+05	3.729+05
195	7.020+10	5.986-01	2.148+11	2.385+03	1.671+00	2.400+00	7.020+10	7.020+10	7.178+05	3.747+05
196	7.056+10	5.986-01	2.156+11	2.396+03	1.671+00	2.400+00	7.056+10	7.056+10	7.191+05	3.754+05
197	7.092+10	5.986-01	2.163+11	2.407+03	1.671+00	2.400+00	7.092+10	7.092+10	7.204+05	3.760+05
198	7.128+10	5.986-01	2.171+11	2.418+03	1.671+00	2.400+00	7.128+10	7.128+10	7.218+05	3.767+05
199	7.164+10	5.972-01	2.187+11	2.427+03	1.674+00	2.400+00	7.164+10	7.164+10	7.236+05	3.785+05
200	7.200+10	5.972-01	2.195+11	2.438+03	1.674+00	2.400+00	7.200+10	7.200+10	7.249+05	3.792+05
201	7.236+10	5.972-01	2.203+11	2.449+03	1.674+00	2.400+00	7.236+10	7.236+10	7.262+05	3.799+05
202	7.272+10	5.972-01	2.211+11	2.460+03	1.674+00	2.400+00	7.272+10	7.272+10	7.275+05	3.805+05
203	7.308+10	5.958-01	2.226+11	2.469+03	1.678+00	2.400+00	7.308+10	7.308+10	7.293+05	3.823+05
204	7.344+10	5.958-01	2.234+11	2.481+03	1.678+00	2.400+00	7.344+10	7.344+10	7.306+05	3.830+05
205	7.380+10	5.958-01	2.242+11	2.492+03	1.678+00	2.400+00	7.380+10	7.380+10	7.319+05	3.836+05
206	7.416+10	5.958-01	2.250+11	2.503+03	1.678+00	2.400+00	7.416+10	7.416+10	7.332+05	3.843+05
207	7.452+10	5.945-01	2.266+11	2.512+03	1.682+00	2.400+00	7.452+10	7.452+10	7.349+05	3.860+05
208	7.488+10	5.945-01	2.273+11	2.523+03	1.682+00	2.400+00	7.488+10	7.488+10	7.362+05	3.867+05
209	7.524+10	5.945-01	2.281+11	2.534+03	1.682+00	2.400+00	7.524+10	7.524+10	7.375+05	3.874+05
210	7.560+10	5.945-01	2.289+11	2.545+03	1.682+00	2.400+00	7.560+10	7.560+10	7.388+05	3.880+05
211	7.596+10	5.932-01	2.305+11	2.554+03	1.686+00	2.400+00	7.596+10	7.596+10	7.405+05	3.887+05

TABLE B.5 (Continued)

100 Percent Water, 20 Percent Porosity Mixture (Continued)

212	[illegible]	5.932-01	2.313+11	2.565+03	1.686+00	2.400+00	7.632+10	7.632+10	7.418+05	3.904+05
213	7.668+10	5.932-01	2.321+11	2.576+03	1.686+00	2.400+00	7.668+10	7.668+10	7.430+05	3.911+05
214	7.704+10	5.932-01	2.328+11	2.587+03	1.686+00	2.400+00	7.704+10	7.704+10	7.443+05	3.917+05
215	7.740+10	5.919-01	2.344+11	2.596+03	1.690+00	2.400+00	7.740+10	7.740+10	7.460+05	3.934+05
216	7.776+10	5.919-01	2.352+11	2.607+03	1.690+00	2.400+00	7.776+10	7.776+10	7.473+05	3.941+05
217	7.812+10	5.919-01	2.360+11	2.618+03	1.690+00	2.400+00	7.812+10	7.812+10	7.485+05	3.947+05
218	7.848+10	5.919-01	2.367+11	2.629+03	1.690+00	2.400+00	7.848+10	7.848+10	7.498+05	3.954+05
219	7.884+10	5.906-01	2.383+11	2.638+03	1.693+00	2.400+00	7.884+10	7.884+10	7.515+05	3.971+05
220	7.920+10	5.906-01	2.391+11	2.649+03	1.693+00	2.400+00	7.920+10	7.920+10	7.527+05	3.977+05
221	7.956+10	5.906-01	2.399+11	2.660+03	1.693+00	2.400+00	7.956+10	7.956+10	7.540+05	3.984+05
222	7.992+10	5.906-01	2.406+11	2.671+03	1.693+00	2.400+00	7.992+10	7.992+10	7.552+05	3.990+05
223	8.028+10	5.893-01	2.422+11	2.680+03	1.697+00	2.400+00	8.028+10	8.028+10	7.569+05	4.007+05
224	8.064+10	5.893-01	2.430+11	2.691+03	1.697+00	2.400+00	8.064+10	8.064+10	7.581+05	4.013+05
225	8.100+10	5.893-01	2.437+11	2.702+03	1.697+00	2.400+00	8.100+10	8.100+10	7.593+05	4.020+05
226	8.136+10	5.893-01	2.445+11	2.713+03	1.697+00	2.400+00	8.136+10	8.136+10	7.606+05	4.026+05
227	8.172+10	5.893-01	2.453+11	2.724+03	1.697+00	2.400+00	8.172+10	8.172+10	7.618+05	4.033+05
228	8.208+10	5.878-01	2.470+11	2.733+03	1.701+00	2.400+00	8.208+10	8.208+10	7.635+05	4.051+05
229	8.244+10	5.878-01	2.478+11	2.744+03	1.701+00	2.400+00	8.244+10	8.244+10	7.647+05	4.058+05
230	8.280+10	5.878-01	2.486+11	2.755+03	1.701+00	2.400+00	8.280+10	8.280+10	7.659+05	4.064+05
231	8.316+10	5.878-01	2.494+11	2.766+03	1.701+00	2.400+00	8.316+10	8.316+10	7.672+05	4.071+05
232	8.352+10	5.878-01	2.502+11	2.777+03	1.701+00	2.400+00	8.352+10	8.352+10	7.684+05	4.077+05
233	8.388+10	5.863-01	2.518+11	2.786+03	1.706+00	2.400+00	8.388+10	8.388+10	7.701+05	4.096+05
234	8.424+10	5.863-01	2.526+11	2.797+03	1.706+00	2.400+00	8.424+10	8.424+10	7.713+05	4.102+05
235	8.460+10	5.863-01	2.534+11	2.808+03	1.706+00	2.400+00	8.460+10	8.460+10	7.725+05	4.108+05
236	8.496+10	5.863-01	2.542+11	2.819+03	1.706+00	2.400+00	8.496+10	8.496+10	7.737+05	4.115+05
237	8.532+10	5.863-01	2.550+11	2.830+03	1.706+00	2.400+00	8.532+10	8.532+10	7.749+05	4.121+05
238	8.568+10	5.848-01	2.567+11	2.839+03	1.710+00	2.400+00	8.568+10	8.568+10	7.765+05	4.139+05
239	8.604+10	5.848-01	2.575+11	2.850+03	1.710+00	2.400+00	8.604+10	8.604+10	7.777+05	4.146+05
240	8.640+10	5.848-01	2.583+11	2.861+03	1.710+00	2.400+00	8.640+10	8.640+10	7.789+05	4.152+05
241	8.676+10	5.848-01	2.591+11	2.872+03	1.710+00	2.400+00	8.676+10	8.676+10	7.801+05	4.156+05
242	8.712+10	5.848-01	2.598+11	2.883+03	1.710+00	2.400+00	8.712+10	8.712+10	7.813+05	4.165+05
243	8.748+10	5.833-01	2.615+11	2.891+03	1.714+00	2.400+00	8.748+10	8.748+10	7.829+05	4.182+05
244	8.784+10	5.833-01	2.623+11	2.902+03	1.714+00	2.400+00	8.784+10	8.784+10	7.841+05	4.189+05
245	8.820+10	5.833-01	2.631+11	2.913+03	1.714+00	2.400+00	8.820+10	8.820+10	7.853+05	4.195+05
246	8.856+10	5.833-01	2.639+11	2.924+03	1.714+00	2.400+00	8.856+10	8.856+10	7.865+05	4.201+05
247	8.892+10	5.833-01	2.647+11	2.935+03	1.714+00	2.400+00	8.892+10	8.892+10	7.876+05	4.208+05
248	8.928+10	5.818-01	2.663+11	2.944+03	1.719+00	2.400+00	8.928+10	8.928+10	7.892+05	4.225+05
249	8.964+10	5.818-01	2.671+11	2.955+03	1.719+00	2.400+00	8.964+10	8.964+10	7.904+05	4.232+05
250	9.000+10	5.818-01	2.679+11	2.966+03	1.719+00	2.400+00	9.000+10	9.000+10	7.916+05	4.238+05
251	9.036+10	5.818-01	2.687+11	2.977+03	1.719+00	2.400+00	9.036+10	9.036+10	7.927+05	4.244+05
252	9.072+10	5.818-01	2.695+11	2.988+03	1.719+00	2.400+00	9.072+10	9.072+10	7.939+05	4.250+05
253	9.108+10	5.804-01	2.711+11	2.997+03	1.723+00	2.400+00	9.108+10	9.108+10	7.955+05	4.268+05
254	9.144+10	5.804-01	2.719+11	3.008+03	1.723+00	2.400+00	9.144+10	9.144+10	7.966+05	4.274+05
255	9.180+10	5.804-01	2.727+11	3.019+03	1.723+00	2.400+00	9.180+10	9.180+10	7.978+05	4.280+05
256	9.216+10	5.804-01	2.735+11	3.030+03	1.723+00	2.400+00	9.216+10	9.216+10	7.989+05	4.286+05
257	9.252+10	5.804-01	2.743+11	3.041+03	1.723+00	2.400+00	9.252+10	9.252+10	8.001+05	4.293+05
258	9.288+10	5.790-01	2.759+11	3.049+03	1.727+00	2.400+00	9.286+10	9.288+10	8.016+05	4.310+05
259	9.324+10	5.790-01	2.767+11	3.060+03	1.727+00	2.400+00	9.324+10	9.324+10	8.028+05	4.316+05
260	9.360+10	5.790-01	2.775+11	3.071+03	1.727+00	2.400+00	9.360+10	9.360+10	8.039+05	4.322+05
261	9.396+10	5.790-01	2.783+11	3.082+03	1.727+00	2.400+00	9.396+10	9.396+10	8.051+05	4.328+05
262	9.432+10	5.790-01	2.790+11	3.093+03	1.727+00	2.400+00	9.432+10	9.432+10	8.062+05	4.334+05
263	9.468+10	5.776-01	2.807+11	3.102+03	1.731+00	2.400+00	9.468+10	9.468+10	8.077+05	4.351+05
264	9.504+10	5.776-01	2.814+11	3.113+03	1.731+00	2.400+00	9.504+10	9.504+10	8.088+05	4.357+05
265	9.540+10	5.776-01	2.822+11	3.124+03	1.731+00	2.400+00	9.540+10	9.540+10	8.100+05	4.363+05

TABLE B.5 (Continued)

100 Percent Water, 20 Percent Porosity Mixture (Continued)

266	9.576+10	5.776-01	2.830+11	3.135+03	1.731+00	2.900+00	9.576+10	9.576+10	8.111+05	9.370+05
267	9.612+10	5.776-01	2.838+11	3.146+03	1.731+00	2.900+00	9.612+10	9.612+10	8.122+05	9.376+05
268	9.648+10	5.776-01	2.846+11	3.157+03	1.731+00	2.900+00	9.648+10	9.648+10	8.134+05	9.382+05
269	9.684+10	5.760-01	2.864+11	3.165+03	1.736+00	2.900+00	9.684+10	9.684+10	8.149+05	9.400+05
270	9.720+10	5.760-01	2.871+11	3.176+03	1.736+00	2.900+00	9.720+10	9.720+10	8.160+05	9.407+05
271	9.756+10	5.760-01	2.879+11	3.187+03	1.736+00	2.900+00	9.756+10	9.756+10	8.171+05	9.413+05
272	9.792+10	5.760-01	2.887+11	3.198+03	1.736+00	2.900+00	9.792+10	9.792+10	8.183+05	9.419+05
273	9.828+10	5.760-01	2.895+11	3.209+03	1.736+00	2.900+00	9.828+10	9.828+10	8.194+05	9.425+05
274	9.864+10	5.760-01	2.903+11	3.220+03	1.736+00	2.900+00	9.864+10	9.864+10	8.205+05	9.431+05
275	9.900+10	5.744-01	2.921+11	3.229+03	1.741+00	2.900+00	9.900+10	9.900+10	8.220+05	9.449+05

TABLE B.5 (Continued)

100 PERCENT WATER, 15 PERCENT POROSITY MIXTURE

K	AIX	TVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	9.182-01	2.767+09	3.156+02	1.089+00	2.400+00	3.600+08	3.600+08	1.215+05	2.684+04
2	7.200+08	8.822-01	4.856+09	3.307+02	1.133+00	2.400+00	7.200+08	7.200+08	1.509+05	3.794+04
3	1.080+09	8.587-01	6.739+09	3.441+02	1.165+00	2.400+00	1.080+09	1.080+09	1.711+05	4.643+04
4	1.440+09	8.410-01	8.526+09	3.568+02	1.189+00	2.400+00	1.440+09	1.440+09	1.873+05	5.365+04
5	1.800+09	8.265-01	1.026+10	3.689+02	1.210+00	2.400+00	1.800+09	1.800+09	2.012+05	6.012+04
6	2.160+09	8.149-01	1.190+10	3.807+02	1.227+00	2.400+00	2.160+09	2.160+09	2.132+05	6.577+04
7	2.520+09	8.049-01	1.349+10	3.922+02	1.242+00	2.400+00	2.520+09	2.520+09	2.239+05	7.100+04
8	2.880+09	7.961-01	1.506+10	4.036+02	1.256+00	2.400+00	2.880+09	2.880+09	2.338+05	7.589+04
9	3.240+09	7.883-01	1.659+10	4.149+02	1.269+00	2.400+00	3.240+09	3.240+09	2.430+05	8.048+04
10	3.600+09	7.812-01	1.811+10	4.260+02	1.280+00	2.400+00	3.600+09	3.600+09	2.516+05	8.483+04
11	3.960+09	7.748-01	1.960+10	4.371+02	1.291+00	2.400+00	3.960+09	3.960+09	2.596+05	8.896+04
12	4.320+09	7.689-01	2.107+10	4.481+02	1.301+00	2.400+00	4.320+09	4.320+09	2.673+05	9.292+04
13	4.680+09	7.634-01	2.253+10	4.590+02	1.310+00	2.400+00	4.680+09	4.680+09	2.745+05	9.671+04
14	5.040+09	7.583-01	2.397+10	4.698+02	1.319+00	2.400+00	5.040+09	5.040+09	2.815+05	1.004+05
15	5.400+09	7.536-01	2.540+10	4.806+02	1.327+00	2.400+00	5.400+09	5.400+09	2.881+05	1.039+05
16	5.760+09	7.492-01	2.681+10	4.914+02	1.335+00	2.400+00	5.760+09	5.760+09	2.945+05	1.073+05
17	6.120+09	7.450-01	2.821+10	5.021+02	1.342+00	2.400+00	6.120+09	6.120+09	3.006+05	1.106+05
18	6.480+09	7.410-01	2.960+10	5.128+02	1.349+00	2.400+00	6.480+09	6.480+09	3.066+05	1.138+05
19	6.840+09	7.373-01	3.098+10	5.235+02	1.356+00	2.400+00	6.840+09	6.840+09	3.123+05	1.169+05
20	7.200+09	7.337-01	3.235+10	5.341+02	1.363+00	2.400+00	7.200+09	7.200+09	3.179+05	1.200+05
21	7.560+09	7.304-01	3.372+10	5.447+02	1.369+00	2.400+00	7.560+09	7.560+09	3.232+05	1.229+05
22	7.920+09	7.271-01	3.507+10	5.553+02	1.375+00	2.400+00	7.920+09	7.920+09	3.285+05	1.258+05
23	8.280+09	7.240-01	3.642+10	5.659+02	1.381+00	2.400+00	8.280+09	8.280+09	3.336+05	1.287+05
24	8.640+09	7.211-01	3.775+10	5.764+02	1.387+00	2.400+00	8.640+09	8.640+09	3.386+05	1.314+05
25	9.000+09	7.182-01	3.909+10	5.870+02	1.392+00	2.400+00	9.000+09	9.000+09	3.434+05	1.341+05
26	9.360+09	7.155-01	4.041+10	5.975+02	1.398+00	2.400+00	9.360+09	9.360+09	3.482+05	1.368+05
27	9.720+09	7.129-01	4.173+10	6.080+02	1.403+00	2.400+00	9.720+09	9.720+09	3.528+05	1.394+05
28	1.008+10	7.103-01	4.304+10	6.185+02	1.408+00	2.400+00	1.008+10	1.008+10	3.573+05	1.420+05
29	1.044+10	7.079-01	4.434+10	6.290+02	1.413+00	2.400+00	1.044+10	1.044+10	3.617+05	1.445+05
30	1.080+10	7.055-01	4.564+10	6.394+02	1.417+00	2.400+00	1.080+10	1.080+10	3.661+05	1.469+05
31	1.116+10	7.032-01	4.694+10	6.499+02	1.422+00	2.400+00	1.116+10	1.116+10	3.703+05	1.494+05
32	1.152+10	7.010-01	4.823+10	6.603+02	1.427+00	2.400+00	1.152+10	1.152+10	3.745+05	1.518+05
33	1.188+10	6.988-01	4.951+10	6.708+02	1.431+00	2.400+00	1.188+10	1.188+10	3.786+05	1.541+05
34	1.224+10	6.967-01	5.079+10	6.812+02	1.435+00	2.400+00	1.224+10	1.224+10	3.827+05	1.564+05
35	1.260+10	6.947-01	5.207+10	6.916+02	1.439+00	2.400+00	1.260+10	1.260+10	3.866+05	1.587+05
36	1.296+10	6.927-01	5.334+10	7.021+02	1.444+00	2.400+00	1.296+10	1.296+10	3.905+05	1.610+05
37	1.332+10	6.908-01	5.460+10	7.125+02	1.448+00	2.400+00	1.332+10	1.332+10	3.943+05	1.632+05
38	1.368+10	6.889-01	5.587+10	7.229+02	1.452+00	2.400+00	1.368+10	1.368+10	3.981+05	1.654+05
39	1.404+10	6.871-01	5.712+10	7.333+02	1.455+00	2.400+00	1.404+10	1.404+10	4.018+05	1.676+05
40	1.440+10	6.853-01	5.838+10	7.437+02	1.459+00	2.400+00	1.440+10	1.440+10	4.055+05	1.697+05
41	1.476+10	6.836-01	5.963+10	7.541+02	1.463+00	2.400+00	1.476+10	1.476+10	4.091+05	1.718+05
42	1.512+10	6.819-01	6.087+10	7.645+02	1.466+00	2.400+00	1.512+10	1.512+10	4.126+05	1.739+05
43	1.548+10	6.803-01	6.212+10	7.748+02	1.470+00	2.400+00	1.548+10	1.548+10	4.161+05	1.759+05
44	1.584+10	6.786-01	6.336+10	7.852+02	1.474+00	2.400+00	1.584+10	1.584+10	4.196+05	1.780+05
45	1.620+10	6.771-01	6.459+10	7.956+02	1.477+00	2.400+00	1.620+10	1.620+10	4.230+05	1.800+05
46	1.656+10	6.755-01	6.583+10	8.060+02	1.480+00	2.400+00	1.656+10	1.656+10	4.263+05	1.820+05
47	1.692+10	6.740-01	6.705+10	8.163+02	1.484+00	2.400+00	1.692+10	1.692+10	4.296+05	1.839+05
48	1.728+10	6.725-01	6.828+10	8.267+02	1.487+00	2.400+00	1.728+10	1.728+10	4.329+05	1.859+05
49	1.764+10	6.711-01	6.950+10	8.370+02	1.490+00	2.400+00	1.764+10	1.764+10	4.362+05	1.878+05

TABLE B.5 (Continued)

100 Percent Water, 15 Percent Porosity Mixture (Continued)

50	1.800+10	6.696-01	7.072+10	8.474+02	1.493+00	2.400+00	1.800+10	1.800+10	4.393+05	1.897+05
51	1.836+10	6.682-01	7.194+10	8.578+02	1.496+00	2.400+00	1.836+10	1.836+10	4.425+05	1.916+05
52	1.872+10	6.669-01	7.316+10	8.681+02	1.500+00	2.400+00	1.872+10	1.872+10	4.456+05	1.935+05
53	1.908+10	6.655-01	7.437+10	8.785+02	1.503+00	2.400+00	1.908+10	1.908+10	4.487+05	1.953+05
54	1.944+10	6.642-01	7.558+10	8.888+02	1.506+00	2.400+00	1.944+10	1.944+10	4.518+05	1.972+05
55	1.980+10	6.629-01	7.678+10	8.991+02	1.508+00	2.400+00	1.980+10	1.980+10	4.548+05	1.990+05
56	2.016+10	6.616-01	7.799+10	9.095+02	1.511+00	2.400+00	2.016+10	2.016+10	4.578+05	2.008+05
57	2.052+10	6.604-01	7.919+10	9.198+02	1.514+00	2.400+00	2.052+10	2.052+10	4.607+05	2.026+05
58	2.088+10	6.592-01	8.039+10	9.302+02	1.517+00	2.400+00	2.088+10	2.088+10	4.637+05	2.043+05
59	2.124+10	6.580-01	8.158+10	9.405+02	1.520+00	2.400+00	2.124+10	2.124+10	4.665+05	2.061+05
60	2.160+10	6.568-01	8.278+10	9.508+02	1.523+00	2.400+00	2.160+10	2.160+10	4.694+05	2.078+05
61	2.196+10	6.556-01	8.397+10	9.612+02	1.525+00	2.400+00	2.196+10	2.196+10	4.723+05	2.096+05
62	2.232+10	6.544-01	8.516+10	9.715+02	1.528+00	2.400+00	2.232+10	2.232+10	4.751+05	2.113+05
63	2.268+10	6.533-01	8.635+10	9.818+02	1.531+00	2.400+00	2.268+10	2.268+10	4.778+05	2.130+05
64	2.304+10	6.522-01	8.753+10	9.921+02	1.533+00	2.400+00	2.304+10	2.304+10	4.806+05	2.147+05
65	2.340+10	6.511-01	8.871+10	1.002+03	1.536+00	2.400+00	2.340+10	2.340+10	4.833+05	2.163+05
66	2.376+10	6.500-01	8.989+10	1.013+03	1.538+00	2.400+00	2.376+10	2.376+10	4.860+05	2.180+05
67	2.412+10	6.489-01	9.107+10	1.023+03	1.541+00	2.400+00	2.412+10	2.412+10	4.887+05	2.196+05
68	2.448+10	6.479-01	9.225+10	1.033+03	1.543+00	2.400+00	2.448+10	2.448+10	4.914+05	2.213+05
69	2.484+10	6.469-01	9.342+10	1.044+03	1.546+00	2.400+00	2.484+10	2.484+10	4.940+05	2.229+05
70	2.520+10	6.458-01	9.460+10	1.054+03	1.548+00	2.400+00	2.520+10	2.520+10	4.966+05	2.245+05
71	2.556+10	6.448-01	9.577+10	1.064+03	1.551+00	2.400+00	2.556+10	2.556+10	4.992+05	2.261+05
72	2.592+10	6.438-01	9.693+10	1.075+03	1.553+00	2.400+00	2.592+10	2.592+10	5.018+05	2.277+05
73	2.628+10	6.428-01	9.810+10	1.085+03	1.556+00	2.400+00	2.628+10	2.628+10	5.043+05	2.293+05
74	2.664+10	6.419-01	9.927+10	1.095+03	1.558+00	2.400+00	2.664+10	2.664+10	5.069+05	2.308+05
75	2.700+10	6.409-01	1.004+11	1.106+03	1.560+00	2.400+00	2.700+10	2.700+10	5.094+05	2.324+05
76	2.736+10	6.400-01	1.016+11	1.116+03	1.563+00	2.400+00	2.736+10	2.736+10	5.119+05	2.339+05
77	2.772+10	6.391-01	1.027+11	1.126+03	1.565+00	2.400+00	2.772+10	2.772+10	5.143+05	2.354+05
78	2.808+10	6.381-01	1.039+11	1.137+03	1.567+00	2.400+00	2.808+10	2.808+10	5.168+05	2.370+05
79	2.844+10	6.372-01	1.051+11	1.147+03	1.569+00	2.400+00	2.844+10	2.844+10	5.192+05	2.385+05
80	2.880+10	6.363-01	1.062+11	1.157+03	1.572+00	2.400+00	2.880+10	2.880+10	5.216+05	2.400+05
81	2.916+10	6.354-01	1.074+11	1.168+03	1.574+00	2.400+00	2.916+10	2.916+10	5.240+05	2.415+05
82	2.952+10	6.346-01	1.085+11	1.178+03	1.576+00	2.400+00	2.952+10	2.952+10	5.264+05	2.430+05
83	2.988+10	6.337-01	1.097+11	1.188+03	1.578+00	2.400+00	2.988+10	2.988+10	5.287+05	2.445+05
84	3.024+10	6.328-01	1.108+11	1.198+03	1.580+00	2.400+00	3.024+10	3.024+10	5.311+05	2.459+05
85	3.060+10	6.328-01	1.116+11	1.209+03	1.580+00	2.400+00	3.060+10	3.060+10	5.329+05	2.468+05
86	3.096+10	6.312-01	1.131+11	1.219+03	1.584+00	2.400+00	3.096+10	3.096+10	5.357+05	2.488+05
87	3.132+10	6.312-01	1.139+11	1.230+03	1.584+00	2.400+00	3.132+10	3.132+10	5.375+05	2.497+05
88	3.168+10	6.295-01	1.154+11	1.240+03	1.588+00	2.400+00	3.168+10	3.168+10	5.403+05	2.517+05
89	3.204+10	6.295-01	1.161+11	1.251+03	1.588+00	2.400+00	3.204+10	3.204+10	5.421+05	2.525+05
90	3.240+10	6.279-01	1.177+11	1.260+03	1.593+00	2.400+00	3.240+10	3.240+10	5.448+05	2.545+05
91	3.276+10	6.279-01	1.184+11	1.271+03	1.593+00	2.400+00	3.276+10	3.276+10	5.466+05	2.554+05
92	3.312+10	6.263-01	1.199+11	1.281+03	1.597+00	2.400+00	3.312+10	3.312+10	5.492+05	2.573+05
93	3.348+10	6.263-01	1.207+11	1.292+03	1.597+00	2.400+00	3.348+10	3.348+10	5.510+05	2.582+05
94	3.384+10	6.248-01	1.222+11	1.301+03	1.601+00	2.400+00	3.384+10	3.384+10	5.536+05	2.601+05
95	3.420+10	6.248-01	1.230+11	1.312+03	1.601+00	2.400+00	3.420+10	3.420+10	5.554+05	2.610+05
96	3.456+10	6.233-01	1.244+11	1.322+03	1.604+00	2.400+00	3.456+10	3.456+10	5.579+05	2.629+05
97	3.492+10	6.233-01	1.252+11	1.333+03	1.604+00	2.400+00	3.492+10	3.492+10	5.597+05	2.637+05
98	3.528+10	6.218-01	1.267+11	1.343+03	1.608+00	2.400+00	3.528+10	3.528+10	5.622+05	2.656+05
99	3.564+10	6.218-01	1.275+11	1.354+03	1.608+00	2.400+00	3.564+10	3.564+10	5.639+05	2.664+05
100	3.600+10	6.203-01	1.290+11	1.363+03	1.612+00	2.400+00	3.600+10	3.600+10	5.665+05	2.683+05
101	3.636+10	6.203-01	1.297+11	1.374+03	1.612+00	2.400+00	3.636+10	3.636+10	5.682+05	2.691+05
102	3.672+10	6.189-01	1.312+11	1.384+03	1.616+00	2.400+00	3.672+10	3.672+10	5.706+05	2.710+05
103	3.708+10	6.189-01	1.320+11	1.395+03	1.616+00	2.400+00	3.708+10	3.708+10	5.723+05	2.718+05

TABLE B.5 (Continued)

100 PERCENT WATER, 15 PERCENT POROSITY MIXTURE

K	AIE	TVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	9.182-01	2.767+09	3.156+02	1.089+00	2.400+00	3.600+08	3.600+08	1.215+05	2.684+04
2	7.200+08	8.822-01	4.856+09	3.307+02	1.133+00	2.400+00	7.200+08	7.200+08	1.509+05	3.794+04
3	1.080+09	8.587-01	6.739+09	3.441+02	1.165+00	2.400+00	1.080+09	1.080+09	1.711+05	4.643+04
4	1.440+09	8.410-01	8.526+09	3.568+02	1.189+00	2.400+00	1.440+09	1.440+09	1.873+05	5.365+04
5	1.800+09	8.265-01	1.026+10	3.689+02	1.210+00	2.400+00	1.800+09	1.800+09	2.012+05	6.012+04
6	2.160+09	8.139-01	1.190+10	3.807+02	1.227+00	2.400+00	2.160+09	2.160+09	2.132+05	6.577+04
7	2.520+09	8.049-01	1.349+10	3.922+02	1.242+00	2.400+00	2.520+09	2.520+09	2.239+05	7.100+04
8	2.880+09	7.961-01	1.506+10	4.036+02	1.256+00	2.400+00	2.880+09	2.880+09	2.338+05	7.589+04
9	3.240+09	7.883-01	1.659+10	4.149+02	1.269+00	2.400+00	3.240+09	3.240+09	2.430+05	8.048+04
10	3.600+09	7.812-01	1.811+10	4.260+02	1.280+00	2.400+00	3.600+09	3.600+09	2.516+05	8.483+04
11	3.960+09	7.748-01	1.960+10	4.371+02	1.291+00	2.400+00	3.960+09	3.960+09	2.596+05	8.896+04
12	4.320+09	7.689-01	2.107+10	4.481+02	1.301+00	2.400+00	4.320+09	4.320+09	2.673+05	9.292+04
13	4.680+09	7.634-01	2.253+10	4.590+02	1.310+00	2.400+00	4.680+09	4.680+09	2.745+05	9.671+04
14	5.040+09	7.583-01	2.397+10	4.698+02	1.319+00	2.400+00	5.040+09	5.040+09	2.815+05	1.004+05
15	5.400+09	7.536-01	2.540+10	4.806+02	1.327+00	2.400+00	5.400+09	5.400+09	2.881+05	1.039+05
16	5.760+09	7.492-01	2.681+10	4.914+02	1.335+00	2.400+00	5.760+09	5.760+09	2.945+05	1.073+05
17	6.120+09	7.450-01	2.821+10	5.021+02	1.342+00	2.400+00	6.120+09	6.120+09	3.006+05	1.106+05
18	6.480+09	7.410-01	2.960+10	5.128+02	1.349+00	2.400+00	6.480+09	6.480+09	3.066+05	1.138+05
19	6.840+09	7.373-01	3.098+10	5.235+02	1.356+00	2.400+00	6.840+09	6.840+09	3.123+05	1.169+05
20	7.200+09	7.337-01	3.235+10	5.341+02	1.363+00	2.400+00	7.200+09	7.200+09	3.179+05	1.200+05
21	7.560+09	7.304-01	3.372+10	5.447+02	1.369+00	2.400+00	7.560+09	7.560+09	3.232+05	1.229+05
22	7.920+09	7.271-01	3.507+10	5.553+02	1.375+00	2.400+00	7.920+09	7.920+09	3.285+05	1.258+05
23	8.280+09	7.240-01	3.642+10	5.659+02	1.381+00	2.400+00	8.280+09	8.280+09	3.336+05	1.287+05
24	8.640+09	7.211-01	3.775+10	5.764+02	1.387+00	2.400+00	8.640+09	8.640+09	3.386+05	1.314+05
25	9.000+09	7.182-01	3.909+10	5.870+02	1.392+00	2.400+00	9.000+09	9.000+09	3.434+05	1.341+05
26	9.360+09	7.155-01	4.041+10	5.975+02	1.398+00	2.400+00	9.360+09	9.360+09	3.482+05	1.368+05
27	9.720+09	7.129-01	4.173+10	6.080+02	1.403+00	2.400+00	9.720+09	9.720+09	3.528+05	1.394+05
28	1.008+10	7.103-01	4.304+10	6.185+02	1.408+00	2.400+00	1.008+10	1.008+10	3.573+05	1.420+05
29	1.044+10	7.079-01	4.434+10	6.290+02	1.413+00	2.400+00	1.044+10	1.044+10	3.617+05	1.445+05
30	1.080+10	7.055-01	4.564+10	6.394+02	1.417+00	2.400+00	1.080+10	1.080+10	3.661+05	1.469+05
31	1.116+10	7.032-01	4.694+10	6.499+02	1.422+00	2.400+00	1.116+10	1.116+10	3.703+05	1.494+05
32	1.152+10	7.010-01	4.823+10	6.603+02	1.427+00	2.400+00	1.152+10	1.152+10	3.745+05	1.518+05
33	1.188+10	6.988-01	4.951+10	6.708+02	1.431+00	2.400+00	1.188+10	1.188+10	3.786+05	1.541+05
34	1.224+10	6.967-01	5.079+10	6.812+02	1.435+00	2.400+00	1.224+10	1.224+10	3.827+05	1.564+05
35	1.260+10	6.947-01	5.207+10	6.916+02	1.439+00	2.400+00	1.260+10	1.260+10	3.866+05	1.587+05
36	1.296+10	6.927-01	5.334+10	7.021+02	1.444+00	2.400+00	1.296+10	1.296+10	3.905+05	1.610+05
37	1.332+10	6.908-01	5.460+10	7.125+02	1.448+00	2.400+00	1.332+10	1.332+10	3.943+05	1.632+05
38	1.368+10	6.889-01	5.587+10	7.229+02	1.452+00	2.400+00	1.368+10	1.368+10	3.981+05	1.654+05
39	1.404+10	6.871-01	5.712+10	7.333+02	1.455+00	2.400+00	1.404+10	1.404+10	4.018+05	1.676+05
40	1.440+10	6.853-01	5.838+10	7.437+02	1.459+00	2.400+00	1.440+10	1.440+10	4.055+05	1.697+05
41	1.476+10	6.836-01	5.963+10	7.541+02	1.463+00	2.400+00	1.476+10	1.476+10	4.091+05	1.718+05
42	1.512+10	6.819-01	6.087+10	7.645+02	1.466+00	2.400+00	1.512+10	1.512+10	4.126+05	1.739+05
43	1.548+10	6.803-01	6.212+10	7.748+02	1.470+00	2.400+00	1.548+10	1.548+10	4.161+05	1.759+05
44	1.584+10	6.786-01	6.336+10	7.852+02	1.474+00	2.400+00	1.584+10	1.584+10	4.196+05	1.780+05
45	1.620+10	6.771-01	6.459+10	7.956+02	1.477+00	2.400+00	1.620+10	1.620+10	4.230+05	1.800+05
46	1.656+10	6.755-01	6.583+10	8.060+02	1.480+00	2.400+00	1.656+10	1.656+10	4.263+05	1.820+05
47	1.692+10	6.740-01	6.705+10	8.163+02	1.484+00	2.400+00	1.692+10	1.692+10	4.296+05	1.839+05
48	1.728+10	6.725-01	6.828+10	8.267+02	1.487+00	2.400+00	1.728+10	1.728+10	4.329+05	1.859+05
49	1.764+10	6.711-01	6.950+10	8.370+02	1.490+00	2.400+00	1.764+10	1.764+10	4.362+05	1.878+05

TABLE B.5 (Continued)

100 Percent Water, 15 Percent Porosity Mixture (Continued)

50	1.800+10	6.696-01	7.072+10	8.475+02	1.493+00	2.900+00	1.800+10	1.800+10	4.393+05	1.897+05
51	1.836+10	6.682-01	7.194+10	8.578+02	1.496+00	2.900+00	1.836+10	1.836+10	4.425+05	1.916+05
52	1.872+10	6.669-01	7.316+10	8.681+02	1.500+00	2.900+00	1.872+10	1.872+10	4.456+05	1.935+05
53	1.908+10	6.655-01	7.437+10	8.785+02	1.503+00	2.900+00	1.908+10	1.908+10	4.487+05	1.953+05
54	1.944+10	6.642-01	7.558+10	8.888+02	1.506+00	2.900+00	1.944+10	1.944+10	4.518+05	1.972+05
55	1.980+10	6.629-01	7.678+10	8.991+02	1.508+00	2.900+00	1.980+10	1.980+10	4.548+05	1.990+05
56	2.016+10	6.616-01	7.799+10	9.095+02	1.511+00	2.900+00	2.016+10	2.016+10	4.578+05	2.008+05
57	2.052+10	6.604-01	7.919+10	9.198+02	1.514+00	2.900+00	2.052+10	2.052+10	4.607+05	2.026+05
58	2.088+10	6.592-01	8.039+10	9.302+02	1.517+00	2.900+00	2.088+10	2.088+10	4.637+05	2.043+05
59	2.124+10	6.580-01	8.158+10	9.405+02	1.520+00	2.900+00	2.124+10	2.124+10	4.665+05	2.061+05
60	2.160+10	6.568-01	8.278+10	9.508+02	1.523+00	2.900+00	2.160+10	2.160+10	4.694+05	2.078+05
61	2.196+10	6.556-01	8.397+10	9.612+02	1.525+00	2.900+00	2.196+10	2.196+10	4.723+05	2.096+05
62	2.232+10	6.544-01	8.516+10	9.715+02	1.528+00	2.900+00	2.232+10	2.232+10	4.751+05	2.113+05
63	2.268+10	6.533-01	8.635+10	9.818+02	1.531+00	2.900+00	2.268+10	2.268+10	4.778+05	2.130+05
64	2.304+10	6.522-01	8.753+10	9.921+02	1.533+00	2.900+00	2.304+10	2.304+10	4.806+05	2.147+05
65	2.340+10	6.511-01	8.871+10	1.002+03	1.536+00	2.900+00	2.340+10	2.340+10	4.833+05	2.163+05
66	2.376+10	6.500-01	8.989+10	1.013+03	1.538+00	2.900+00	2.376+10	2.376+10	4.860+05	2.180+05
67	2.412+10	6.489-01	9.107+10	1.023+03	1.541+00	2.900+00	2.412+10	2.412+10	4.887+05	2.196+05
68	2.448+10	6.479-01	9.225+10	1.033+03	1.543+00	2.900+00	2.448+10	2.448+10	4.914+05	2.213+05
69	2.484+10	6.469-01	9.342+10	1.044+03	1.546+00	2.900+00	2.484+10	2.484+10	4.940+05	2.229+05
70	2.520+10	6.458-01	9.460+10	1.054+03	1.548+00	2.900+00	2.520+10	2.520+10	4.966+05	2.245+05
71	2.556+10	6.448-01	9.577+10	1.064+03	1.551+00	2.900+00	2.556+10	2.556+10	4.992+05	2.261+05
72	2.592+10	6.438-01	9.693+10	1.075+03	1.553+00	2.900+00	2.592+10	2.592+10	5.018+05	2.277+05
73	2.628+10	6.428-01	9.810+10	1.085+03	1.556+00	2.900+00	2.628+10	2.628+10	5.043+05	2.293+05
74	2.664+10	6.419-01	9.927+10	1.095+03	1.558+00	2.900+00	2.664+10	2.664+10	5.069+05	2.308+05
75	2.700+10	6.409-01	1.004+11	1.106+03	1.560+00	2.900+00	2.700+10	2.700+10	5.094+05	2.324+05
76	2.736+10	6.400-01	1.016+11	1.116+03	1.563+00	2.900+00	2.736+10	2.736+10	5.119+05	2.339+05
77	2.772+10	6.391-01	1.027+11	1.126+03	1.565+00	2.900+00	2.772+10	2.772+10	5.143+05	2.354+05
78	2.808+10	6.381-01	1.039+11	1.137+03	1.567+00	2.900+00	2.808+10	2.808+10	5.168+05	2.370+05
79	2.844+10	6.372-01	1.051+11	1.147+03	1.569+00	2.900+00	2.844+10	2.844+10	5.192+05	2.385+05
80	2.880+10	6.363-01	1.062+11	1.157+03	1.572+00	2.900+00	2.880+10	2.880+10	5.216+05	2.400+05
81	2.916+10	6.354-01	1.074+11	1.168+03	1.574+00	2.900+00	2.916+10	2.916+10	5.240+05	2.415+05
82	2.952+10	6.346-01	1.085+11	1.178+03	1.576+00	2.900+00	2.952+10	2.952+10	5.264+05	2.430+05
83	2.988+10	6.337-01	1.097+11	1.188+03	1.578+00	2.900+00	2.988+10	2.988+10	5.287+05	2.445+05
84	3.024+10	6.328-01	1.108+11	1.198+03	1.580+00	2.900+00	3.024+10	3.024+10	5.311+05	2.459+05
85	3.060+10	6.328-01	1.116+11	1.209+03	1.580+00	2.900+00	3.060+10	3.060+10	5.329+05	2.468+05
86	3.096+10	6.312-01	1.131+11	1.219+03	1.584+00	2.900+00	3.096+10	3.096+10	5.357+05	2.488+05
87	3.132+10	6.312-01	1.139+11	1.230+03	1.584+00	2.900+00	3.132+10	3.132+10	5.375+05	2.497+05
88	3.168+10	6.295-01	1.154+11	1.240+03	1.588+00	2.900+00	3.168+10	3.168+10	5.403+05	2.517+05
89	3.204+10	6.295-01	1.161+11	1.251+03	1.588+00	2.900+00	3.204+10	3.204+10	5.421+05	2.525+05
90	3.240+10	6.279-01	1.177+11	1.260+03	1.593+00	2.900+00	3.240+10	3.240+10	5.448+05	2.545+05
91	3.276+10	6.279-01	1.184+11	1.271+03	1.593+00	2.900+00	3.276+10	3.276+10	5.466+05	2.554+05
92	3.312+10	6.263-01	1.199+11	1.281+03	1.597+00	2.900+00	3.312+10	3.312+10	5.492+05	2.573+05
93	3.348+10	6.263-01	1.207+11	1.292+03	1.597+00	2.900+00	3.348+10	3.348+10	5.510+05	2.582+05
94	3.384+10	6.248-01	1.222+11	1.301+03	1.601+00	2.900+00	3.384+10	3.384+10	5.536+05	2.601+05
95	3.420+10	6.248-01	1.230+11	1.312+03	1.601+00	2.900+00	3.420+10	3.420+10	5.554+05	2.610+05
96	3.456+10	6.233-01	1.244+11	1.322+03	1.604+00	2.900+00	3.456+10	3.456+10	5.579+05	2.629+05
97	3.492+10	6.233-01	1.252+11	1.333+03	1.604+00	2.900+00	3.492+10	3.492+10	5.597+05	2.637+05
98	3.528+10	6.218-01	1.267+11	1.343+03	1.608+00	2.900+00	3.528+10	3.528+10	5.622+05	2.656+05
99	3.564+10	6.218-01	1.275+11	1.354+03	1.608+00	2.900+00	3.564+10	3.564+10	5.639+05	2.664+05
100	3.600+10	6.203-01	1.290+11	1.363+03	1.612+00	2.900+00	3.600+10	3.600+10	5.665+05	2.683+05
101	3.636+10	6.203-01	1.297+11	1.374+03	1.612+00	2.900+00	3.636+10	3.636+10	5.682+05	2.691+05
102	3.672+10	6.189-01	1.312+11	1.384+03	1.616+00	2.900+00	3.672+10	3.672+10	5.706+05	2.710+05
103	3.708+10	6.189-01	1.320+11	1.395+03	1.616+00	2.900+00	3.708+10	3.708+10	5.723+05	2.718+05

TABLE B.5 (Continued)

100 Percent Water, 15 Percent Porosity Mixture (Continued)

104	3.744+10	6.175-01	1.334+11	1.404+03	1.619+00	2.400+00	3.744+10	3.744+10	5.748+05	2.736+05
105	3.780+10	6.175-01	1.342+11	1.415+03	1.619+00	2.400+00	3.780+10	3.780+10	5.764+05	2.744+05
106	3.816+10	6.161-01	1.357+11	1.425+03	1.623+00	2.400+00	3.816+10	3.816+10	5.788+05	2.762+05
107	3.852+10	6.161-01	1.364+11	1.436+03	1.623+00	2.400+00	3.852+10	3.852+10	5.805+05	2.770+05
108	3.888+10	6.148-01	1.379+11	1.446+03	1.627+00	2.400+00	3.888+10	3.888+10	5.829+05	2.788+05
109	3.924+10	6.148-01	1.387+11	1.457+03	1.627+00	2.400+00	3.924+10	3.924+10	5.845+05	2.796+05
110	3.960+10	6.134-01	1.401+11	1.466+03	1.630+00	2.400+00	3.960+10	3.960+10	5.869+05	2.814+05
111	3.996+10	6.134-01	1.409+11	1.477+03	1.630+00	2.400+00	3.996+10	3.996+10	5.885+05	2.822+05
112	4.032+10	6.121-01	1.423+11	1.487+03	1.634+00	2.400+00	4.032+10	4.032+10	5.908+05	2.840+05
113	4.068+10	6.121-01	1.431+11	1.498+03	1.634+00	2.400+00	4.068+10	4.068+10	5.924+05	2.847+05
114	4.104+10	6.109-01	1.446+11	1.507+03	1.637+00	2.400+00	4.104+10	4.104+10	5.947+05	2.865+05
115	4.140+10	6.109-01	1.453+11	1.518+03	1.637+00	2.400+00	4.140+10	4.140+10	5.963+05	2.873+05
116	4.176+10	6.096-01	1.468+11	1.528+03	1.640+00	2.400+00	4.176+10	4.176+10	5.986+05	2.890+05
117	4.212+10	6.096-01	1.475+11	1.539+03	1.640+00	2.400+00	4.212+10	4.212+10	6.002+05	2.897+05
118	4.248+10	6.083-01	1.490+11	1.549+03	1.644+00	2.400+00	4.248+10	4.248+10	6.024+05	2.915+05
119	4.284+10	6.083-01	1.498+11	1.560+03	1.644+00	2.400+00	4.284+10	4.284+10	6.040+05	2.922+05
120	4.320+10	6.071-01	1.512+11	1.569+03	1.647+00	2.400+00	4.320+10	4.320+10	6.062+05	2.939+05
121	4.356+10	6.071-01	1.520+11	1.580+03	1.647+00	2.400+00	4.356+10	4.356+10	6.077+05	2.947+05
122	4.392+10	6.059-01	1.534+11	1.590+03	1.650+00	2.400+00	4.392+10	4.392+10	6.099+05	2.964+05
123	4.428+10	6.059-01	1.541+11	1.601+03	1.650+00	2.400+00	4.428+10	4.428+10	6.115+05	2.971+05
124	4.464+10	6.047-01	1.556+11	1.610+03	1.654+00	2.400+00	4.464+10	4.464+10	6.136+05	2.988+05
125	4.500+10	6.047-01	1.563+11	1.621+03	1.654+00	2.400+00	4.500+10	4.500+10	6.152+05	2.995+05
126	4.536+10	6.036-01	1.577+11	1.631+03	1.657+00	2.400+00	4.536+10	4.536+10	6.173+05	3.012+05
127	4.572+10	6.036-01	1.585+11	1.642+03	1.657+00	2.400+00	4.572+10	4.572+10	6.188+05	3.019+05
128	4.608+10	6.024-01	1.599+11	1.651+03	1.660+00	2.400+00	4.608+10	4.608+10	6.209+05	3.036+05
129	4.644+10	6.024-01	1.607+11	1.662+03	1.660+00	2.400+00	4.644+10	4.644+10	6.225+05	3.043+05
130	4.680+10	6.013-01	1.621+11	1.672+03	1.663+00	2.400+00	4.680+10	4.680+10	6.245+05	3.059+05
131	4.716+10	6.013-01	1.629+11	1.683+03	1.663+00	2.400+00	4.716+10	4.716+10	6.260+05	3.067+05
132	4.752+10	6.001-01	1.643+11	1.693+03	1.666+00	2.400+00	4.752+10	4.752+10	6.281+05	3.083+05
133	4.788+10	6.001-01	1.651+11	1.704+03	1.666+00	2.400+00	4.788+10	4.788+10	6.296+05	3.090+05
134	4.824+10	5.990-01	1.665+11	1.713+03	1.669+00	2.400+00	4.824+10	4.824+10	6.316+05	3.106+05
135	4.860+10	5.990-01	1.672+11	1.724+03	1.669+00	2.400+00	4.860+10	4.860+10	6.331+05	3.113+05
136	4.896+10	5.979-01	1.686+11	1.734+03	1.672+00	2.400+00	4.896+10	4.896+10	6.351+05	3.129+05
137	4.932+10	5.979-01	1.694+11	1.745+03	1.672+00	2.400+00	4.932+10	4.932+10	6.366+05	3.136+05
138	4.968+10	5.969-01	1.708+11	1.754+03	1.675+00	2.400+00	4.968+10	4.968+10	6.386+05	3.152+05
139	5.004+10	5.969-01	1.716+11	1.765+03	1.675+00	2.400+00	5.004+10	5.004+10	6.401+05	3.159+05
140	5.040+10	5.958-01	1.729+11	1.775+03	1.678+00	2.400+00	5.040+10	5.040+10	6.420+05	3.175+05
141	5.076+10	5.958-01	1.737+11	1.786+03	1.678+00	2.400+00	5.076+10	5.076+10	6.435+05	3.182+05
142	5.112+10	5.947-01	1.751+11	1.795+03	1.681+00	2.400+00	5.112+10	5.112+10	6.454+05	3.197+05
143	5.148+10	5.947-01	1.759+11	1.806+03	1.681+00	2.400+00	5.148+10	5.148+10	6.469+05	3.205+05
144	5.184+10	5.937-01	1.772+11	1.816+03	1.684+00	2.400+00	5.184+10	5.184+10	6.488+05	3.220+05
145	5.220+10	5.937-01	1.780+11	1.827+03	1.684+00	2.400+00	5.220+10	5.220+10	6.503+05	3.227+05
146	5.256+10	5.927-01	1.794+11	1.836+03	1.687+00	2.400+00	5.256+10	5.256+10	6.522+05	3.242+05
147	5.292+10	5.927-01	1.802+11	1.847+03	1.687+00	2.400+00	5.292+10	5.292+10	6.536+05	3.249+05
148	5.328+10	5.927-01	1.810+11	1.859+03	1.687+00	2.400+00	5.328+10	5.328+10	6.550+05	3.256+05
149	5.364+10	5.912-01	1.826+11	1.867+03	1.691+00	2.400+00	5.364+10	5.364+10	6.571+05	3.275+05
150	5.400+10	5.912-01	1.834+11	1.878+03	1.691+00	2.400+00	5.400+10	5.400+10	6.585+05	3.282+05
151	5.436+10	5.912-01	1.842+11	1.889+03	1.691+00	2.400+00	5.436+10	5.436+10	6.600+05	3.289+05
152	5.472+10	5.897-01	1.858+11	1.898+03	1.696+00	2.400+00	5.472+10	5.472+10	6.620+05	3.308+05
153	5.508+10	5.897-01	1.866+11	1.909+03	1.696+00	2.400+00	5.508+10	5.508+10	6.634+05	3.315+05
154	5.544+10	5.897-01	1.874+11	1.920+03	1.696+00	2.400+00	5.544+10	5.544+10	6.648+05	3.322+05
155	5.580+10	5.883-01	1.890+11	1.929+03	1.700+00	2.400+00	5.580+10	5.580+10	6.669+05	3.340+05
156	5.616+10	5.883-01	1.898+11	1.940+03	1.700+00	2.400+00	5.616+10	5.616+10	6.683+05	3.347+05
157	5.652+10	5.883-01	1.906+11	1.951+03	1.700+00	2.400+00	5.652+10	5.652+10	6.697+05	3.354+05

TABLE B.5 (Continued)

100 Percent Water, 15 Percent Porosity Mixture (Continued)

158	5.688+10	5.868-01	1.922+11	1.960+03	1.704+00	2.400+00	5.688+10	5.688+10	6.717+05	3.372+05
159	5.724+10	5.868-01	1.930+11	1.971+03	1.704+00	2.400+00	5.724+10	5.724+10	6.731+05	3.379+05
160	5.760+10	5.868-01	1.938+11	1.982+03	1.704+00	2.400+00	5.760+10	5.760+10	6.744+05	3.386+05
161	5.796+10	5.854-01	1.954+11	1.991+03	1.708+00	2.400+00	5.796+10	5.796+10	6.764+05	3.404+05
162	5.832+10	5.854-01	1.962+11	2.002+03	1.708+00	2.400+00	5.832+10	5.832+10	6.778+05	3.411+05
163	5.868+10	5.854-01	1.970+11	2.013+03	1.708+00	2.400+00	5.868+10	5.868+10	6.792+05	3.418+05
164	5.904+10	5.840-01	1.986+11	2.021+03	1.712+00	2.400+00	5.904+10	5.904+10	6.811+05	3.436+05
165	5.940+10	5.840-01	1.994+11	2.032+03	1.712+00	2.400+00	5.940+10	5.940+10	6.825+05	3.443+05
166	5.976+10	5.840-01	2.001+11	2.044+03	1.712+00	2.400+00	5.976+10	5.976+10	6.838+05	3.450+05
167	6.012+10	5.827-01	2.017+11	2.052+03	1.716+00	2.400+00	6.012+10	6.012+10	6.857+05	3.467+05
168	6.048+10	5.827-01	2.025+11	2.063+03	1.716+00	2.400+00	6.048+10	6.048+10	6.871+05	3.474+05
169	6.084+10	5.827-01	2.033+11	2.074+03	1.716+00	2.400+00	6.084+10	6.084+10	6.884+05	3.481+05
170	6.120+10	5.813-01	2.049+11	2.083+03	1.720+00	2.400+00	6.120+10	6.120+10	6.903+05	3.498+05
171	6.156+10	5.813-01	2.057+11	2.094+03	1.720+00	2.400+00	6.156+10	6.156+10	6.916+05	3.505+05
172	6.192+10	5.813-01	2.065+11	2.105+03	1.720+00	2.400+00	6.192+10	6.192+10	6.930+05	3.512+05
173	6.228+10	5.800-01	2.080+11	2.114+03	1.724+00	2.400+00	6.228+10	6.228+10	6.948+05	3.529+05
174	6.264+10	5.800-01	2.088+11	2.125+03	1.724+00	2.400+00	6.264+10	6.264+10	6.962+05	3.536+05
175	6.300+10	5.800-01	2.096+11	2.136+03	1.724+00	2.400+00	6.300+10	6.300+10	6.975+05	3.542+05
176	6.336+10	5.787-01	2.112+11	2.145+03	1.728+00	2.400+00	6.336+10	6.336+10	6.993+05	3.559+05
177	6.372+10	5.787-01	2.120+11	2.156+03	1.728+00	2.400+00	6.372+10	6.372+10	7.006+05	3.566+05
178	6.408+10	5.787-01	2.128+11	2.167+03	1.728+00	2.400+00	6.408+10	6.408+10	7.019+05	3.573+05
179	6.444+10	5.774-01	2.143+11	2.176+03	1.732+00	2.400+00	6.444+10	6.444+10	7.038+05	3.590+05
180	6.480+10	5.774-01	2.151+11	2.187+03	1.732+00	2.400+00	6.480+10	6.480+10	7.050+05	3.596+05
181	6.516+10	5.774-01	2.159+11	2.198+03	1.732+00	2.400+00	6.516+10	6.516+10	7.063+05	3.603+05
182	6.552+10	5.762-01	2.175+11	2.206+03	1.736+00	2.400+00	6.552+10	6.552+10	7.081+05	3.620+05
183	6.588+10	5.762-01	2.183+11	2.217+03	1.736+00	2.400+00	6.588+10	6.588+10	7.094+05	3.626+05
184	6.624+10	5.762-01	2.191+11	2.228+03	1.736+00	2.400+00	6.624+10	6.624+10	7.107+05	3.633+05
185	6.660+10	5.749-01	2.206+11	2.237+03	1.739+00	2.400+00	6.660+10	6.660+10	7.125+05	3.649+05
186	6.696+10	5.749-01	2.214+11	2.248+03	1.739+00	2.400+00	6.696+10	6.696+10	7.138+05	3.656+05
187	6.732+10	5.749-01	2.222+11	2.259+03	1.739+00	2.400+00	6.732+10	6.732+10	7.150+05	3.662+05
188	6.768+10	5.737-01	2.237+11	2.268+03	1.743+00	2.400+00	6.768+10	6.768+10	7.168+05	3.679+05
189	6.804+10	5.737-01	2.245+11	2.279+03	1.743+00	2.400+00	6.804+10	6.804+10	7.180+05	3.685+05
190	6.840+10	5.737-01	2.253+11	2.290+03	1.743+00	2.400+00	6.840+10	6.840+10	7.193+05	3.692+05
191	6.876+10	5.725-01	2.268+11	2.299+03	1.747+00	2.400+00	6.876+10	6.876+10	7.210+05	3.708+05
192	6.912+10	5.725-01	2.276+11	2.310+03	1.747+00	2.400+00	6.912+10	6.912+10	7.223+05	3.714+05
193	6.948+10	5.725-01	2.284+11	2.321+03	1.747+00	2.400+00	6.948+10	6.948+10	7.235+05	3.721+05
194	6.984+10	5.713-01	2.300+11	2.329+03	1.750+00	2.400+00	6.984+10	6.984+10	7.252+05	3.737+05
195	7.020+10	5.713-01	2.307+11	2.340+03	1.750+00	2.400+00	7.020+10	7.020+10	7.265+05	3.743+05
196	7.056+10	5.713-01	2.315+11	2.352+03	1.750+00	2.400+00	7.056+10	7.056+10	7.277+05	3.750+05
197	7.092+10	5.701-01	2.331+11	2.360+03	1.754+00	2.400+00	7.092+10	7.092+10	7.294+05	3.766+05
198	7.128+10	5.701-01	2.339+11	2.371+03	1.754+00	2.400+00	7.128+10	7.128+10	7.306+05	3.772+05
199	7.164+10	5.701-01	2.346+11	2.382+03	1.754+00	2.400+00	7.164+10	7.164+10	7.319+05	3.779+05
200	7.200+10	5.689-01	2.362+11	2.391+03	1.758+00	2.400+00	7.200+10	7.200+10	7.335+05	3.794+05
201	7.236+10	5.689-01	2.369+11	2.402+03	1.758+00	2.400+00	7.236+10	7.236+10	7.348+05	3.801+05
202	7.272+10	5.689-01	2.377+11	2.413+03	1.758+00	2.400+00	7.272+10	7.272+10	7.360+05	3.807+05
203	7.308+10	5.678-01	2.393+11	2.422+03	1.761+00	2.400+00	7.308+10	7.308+10	7.376+05	3.823+05
204	7.344+10	5.678-01	2.400+11	2.433+03	1.761+00	2.400+00	7.344+10	7.344+10	7.389+05	3.829+05
205	7.380+10	5.678-01	2.408+11	2.444+03	1.761+00	2.400+00	7.380+10	7.380+10	7.401+05	3.835+05
206	7.416+10	5.678-01	2.416+11	2.455+03	1.761+00	2.400+00	7.416+10	7.416+10	7.413+05	3.842+05
207	7.452+10	5.663-01	2.433+11	2.463+03	1.766+00	2.400+00	7.452+10	7.452+10	7.430+05	3.860+05
208	7.488+10	5.663-01	2.441+11	2.474+03	1.766+00	2.400+00	7.488+10	7.488+10	7.442+05	3.866+05
209	7.524+10	5.663-01	2.449+11	2.485+03	1.766+00	2.400+00	7.524+10	7.524+10	7.454+05	3.872+05
210	7.560+10	5.652-01	2.464+11	2.494+03	1.769+00	2.400+00	7.560+10	7.560+10	7.470+05	3.888+05
211	7.596+10	5.652-01	2.472+11	2.505+03	1.769+00	2.400+00	7.596+10	7.596+10	7.482+05	3.894+05

TABLE B.5 (Continued)

100 Percent Water, 15 Percent Porosity Mixture (Continued)

212	7.632+10	5.652-01	2.480+11	2.516+03	1.769+00	2.400+00	7.632+10	7.632+10	7.499+05	3.901+05
213	7.668+10	5.652-01	2.488+11	2.527+03	1.769+00	2.400+00	7.668+10	7.668+10	7.506+05	3.907+05
214	7.704+10	5.637-01	2.505+11	2.535+03	1.774+00	2.400+00	7.704+10	7.704+10	7.523+05	3.925+05
215	7.740+10	5.637-01	2.513+11	2.546+03	1.774+00	2.400+00	7.740+10	7.740+10	7.535+05	3.931+05
216	7.776+10	5.637-01	2.521+11	2.557+03	1.774+00	2.500+00	7.776+10	7.776+10	7.547+05	3.937+05
217	7.812+10	5.637-01	2.529+11	2.568+03	1.774+00	2.400+00	7.812+10	7.812+10	7.559+05	3.943+05
218	7.848+10	5.623-01	2.546+11	2.576+03	1.778+00	2.400+00	7.848+10	7.848+10	7.575+05	3.961+05
219	7.884+10	5.623-01	2.554+11	2.587+03	1.778+00	2.400+00	7.884+10	7.884+10	7.587+05	3.967+05
220	7.920+10	5.623-01	2.562+11	2.598+03	1.778+00	2.400+00	7.920+10	7.920+10	7.599+05	3.973+05
221	7.956+10	5.623-01	2.570+11	2.609+03	1.778+00	2.400+00	7.956+10	7.956+10	7.610+05	3.980+05
222	7.992+10	5.609-01	2.587+11	2.617+03	1.783+00	2.400+00	7.992+10	7.992+10	7.627+05	3.997+05
223	8.028+10	5.609-01	2.595+11	2.628+03	1.783+00	2.400+00	8.028+10	8.028+10	7.639+05	4.003+05
224	8.064+10	5.609-01	2.603+11	2.639+03	1.783+00	2.400+00	8.064+10	8.064+10	7.650+05	4.010+05
225	8.100+10	5.609-01	2.610+11	2.650+03	1.783+00	2.400+00	8.100+10	8.100+10	7.662+05	4.016+05
226	8.136+10	5.595-01	2.627+11	2.658+03	1.787+00	2.400+00	8.136+10	8.136+10	7.678+05	4.033+05
227	8.172+10	5.595-01	2.635+11	2.669+03	1.787+00	2.400+00	8.172+10	8.172+10	7.689+05	4.039+05
228	8.208+10	5.595-01	2.643+11	2.680+03	1.787+00	2.400+00	8.208+10	8.208+10	7.701+05	4.045+05
229	8.244+10	5.595-01	2.651+11	2.691+03	1.787+00	2.400+00	8.244+10	8.244+10	7.712+05	4.051+05
230	8.280+10	5.581-01	2.668+11	2.699+03	1.792+00	2.400+00	8.280+10	8.280+10	7.728+05	4.069+05
231	8.316+10	5.581-01	2.676+11	2.710+03	1.792+00	2.400+00	8.316+10	8.316+10	7.740+05	4.075+05
232	8.352+10	5.581-01	2.684+11	2.721+03	1.792+00	2.400+00	8.352+10	8.352+10	7.751+05	4.081+05
233	8.388+10	5.581-01	2.692+11	2.732+03	1.792+00	2.400+00	8.388+10	8.388+10	7.762+05	4.087+05
234	8.424+10	5.567-01	2.709+11	2.740+03	1.796+00	2.400+00	8.424+10	8.424+10	7.778+05	4.104+05
235	8.460+10	5.567-01	2.716+11	2.751+03	1.796+00	2.400+00	8.460+10	6.460+10	7.790+05	4.110-05
236	8.496+10	5.567-01	2.724+11	2.762+03	1.796+00	2.400+00	8.496+10	8.496+10	7.801+05	4.116+05
237	8.532+10	5.567-01	2.732+11	2.773+03	1.796+00	2.400+00	8.532+10	8.532+10	7.812+05	4.122+05
238	8.568+10	5.554-01	2.749+11	2.781+03	1.801+00	2.400+00	8.568+10	8.568+10	7.828+05	4.139+05
239	8.604+10	5.554-01	2.757+11	2.792+03	1.801+00	2.400+00	8.604+10	8.604+10	7.839+05	4.145+05
240	8.640+10	5.554-01	2.765+11	2.803+03	1.801+00	2.400+00	8.640+10	8.640+10	7.850+05	4.151+05
241	8.676+10	5.554-01	2.772+11	2.814+03	1.801+00	2.400+00	8.676+10	8.676+10	7.861+05	4.157+05
242	8.712+10	5.541-01	2.789+11	2.821+03	1.805+00	2.400+00	8.712+10	8.712+10	7.877+05	4.174+05
243	8.748+10	5.541-01	2.797+11	2.833+03	1.805+00	2.400+00	8.748+10	8.748+10	7.888+05	4.179+05
244	8.784+10	5.541-01	2.805+11	2.844+03	1.805+00	2.400+00	8.784+10	8.784+10	7.899+05	4.185+05
245	8.820+10	5.541-01	2.813+11	2.855+03	1.805+00	2.400+00	8.820+10	8.820+10	7.910+05	4.191+05
246	8.856+10	5.528-01	2.829+11	2.862+03	1.809+00	2.400+00	8.856+10	8.856+10	7.925+05	4.208+05
247	8.892+10	5.528-01	2.837+11	2.873+03	1.809+00	2.400+00	8.892+10	8.892+10	7.936+05	4.214+05
248	8.928+10	5.528-01	2.845+11	2.884+03	1.809+00	2.400+00	8.928+10	8.928+10	7.947+05	4.220+05
249	8.964+10	5.528-01	2.853+11	2.896+03	1.809+00	2.400+00	8.964+10	8.964+10	7.958+05	4.225+05
250	9.000+10	5.515-01	2.870+11	2.903+03	1.813+00	2.400+00	9.000+10	9.000+10	7.973+05	4.242+05
251	9.036+10	5.515-01	2.877+11	2.914+03	1.813+00	2.400+00	9.036+10	9.036+10	7.983+05	4.248+05
252	9.072+10	5.515-01	2.885+11	2.925+03	1.813+00	2.400+00	9.072+10	9.072+10	7.994+05	4.254+05
253	9.108+10	5.515-01	2.893+11	2.936+03	1.813+00	2.400+00	9.108+10	9.108+10	8.005+05	4.259+05
254	9.144+10	5.502-01	2.910+11	2.944+03	1.817+00	2.400+00	9.144+10	9.144+10	8.020+05	4.276+05
255	9.180+10	5.502-01	2.917+11	2.955+03	1.817+00	2.400+00	9.180+10	9.180+10	8.031+05	4.282+05
256	9.216+10	5.502-01	2.925+11	2.966+03	1.817+00	2.400+00	9.216+10	9.216+10	8.041+05	4.287+05
257	9.252+10	5.502-01	2.933+11	2.977+03	1.817+00	2.400+00	9.252+10	9.252+10	8.052+05	4.293+05
258	9.288+10	5.490-01	2.950+11	2.985+03	1.822+00	2.400+00	9.288+10	9.288+10	8.067+05	4.309+05
259	9.324+10	5.490-01	2.957+11	2.996+03	1.822+00	2.400+00	9.324+10	9.324+10	8.077+05	4.315+05
260	9.360+10	5.490-01	2.965+11	3.007+03	1.822+00	2.400+00	9.360+10	9.360+10	8.088+05	4.321+05
261	9.396+10	5.490-01	2.973+11	3.018+03	1.822+00	2.400+00	9.396+10	9.396+10	8.099+05	4.326+05
262	9.432+10	5.477-01	2.989+11	3.026+03	1.826+00	2.400+00	9.432+10	9.432+10	8.113+05	4.343+05
263	9.468+10	5.477-01	2.997+11	3.037+03	1.826+00	2.400+00	9.468+10	9.468+10	8.124+05	4.348+05
264	9.504+10	5.477-01	3.005+11	3.048+03	1.826+00	2.400+00	9.504+10	9.504+10	8.134+05	4.354+05

TABLE B.5 (Continued)

100 PERCENT WATER, 10 PERCENT POROSITY MIXTURE

K	AIX	TVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	9.035-01	3.438+09	3.173+02	1.107+00	2.400+00	3.600+08	3.600+08	1.426+05	2.684+04
2	7.200+08	8.669-01	5.844+09	3.323+02	1.154+00	2.400+00	7.200+08	7.200+08	1.715+05	3.793+04
3	1.080+09	8.432-01	7.984+09	3.455+02	1.186+00	2.400+00	1.080+09	1.080+09	1.914+05	4.643+04
4	1.440+09	8.253-01	1.000+10	3.580+02	1.212+00	2.400+00	1.440+09	1.440+09	2.075+05	5.365+04
5	1.800+09	8.108-01	1.195+10	3.699+02	1.233+00	2.400+00	1.800+09	1.800+09	2.213+05	6.012+04
6	2.160+09	7.991-01	1.378+10	3.815+02	1.251+00	2.400+00	2.160+09	2.160+09	2.332+05	6.577+04
7	2.520+09	7.890-01	1.556+10	3.928+02	1.267+00	2.400+00	2.520+09	2.520+09	2.439+05	7.100+04
8	2.880+09	7.801-01	1.729+10	4.040+02	1.282+00	2.400+00	2.880+09	2.880+09	2.537+05	7.588+04
9	3.240+09	7.722-01	1.900+10	4.150+02	1.295+00	2.400+00	3.240+09	3.240+09	2.628+05	8.048+04
10	3.600+09	7.651-01	2.067+10	4.259+02	1.307+00	2.400+00	3.600+09	3.600+09	2.713+05	8.482+04
11	3.960+09	7.585-01	2.232+10	4.367+02	1.318+00	2.400+00	3.960+09	3.960+09	2.793+05	8.896+04
12	4.320+09	7.525-01	2.394+10	4.475+02	1.329+00	2.400+00	4.320+09	4.320+09	2.868+05	9.292+04
13	4.680+09	7.470-01	2.555+10	4.582+02	1.339+00	2.400+00	4.680+09	4.680+09	2.940+05	9.671+04
14	5.040+09	7.418-01	2.713+10	4.688+02	1.348+00	2.400+00	5.040+09	5.040+09	3.009+05	1.004+05
15	5.400+09	7.370-01	2.870+10	4.793+02	1.357+00	2.400+00	5.400+09	5.400+09	3.075+05	1.039+05
16	5.760+09	7.325-01	3.025+10	4.898+02	1.365+00	2.400+00	5.760+09	5.760+09	3.138+05	1.073+05
17	6.120+09	7.282-01	3.178+10	5.003+02	1.373+00	2.400+00	6.120+09	6.120+09	3.199+05	1.106+05
18	6.480+09	7.242-01	3.330+10	5.108+02	1.381+00	2.400+00	6.480+09	6.480+09	3.257+05	1.138+05
19	6.840+09	7.204-01	3.481+10	5.212+02	1.388+00	2.400+00	6.840+09	6.840+09	3.314+05	1.169+05
20	7.200+09	7.167-01	3.631+10	5.315+02	1.395+00	2.400+00	7.200+09	7.200+09	3.369+05	1.200+05
21	7.560+09	7.132-01	3.779+10	5.419+02	1.402+00	2.400+00	7.560+09	7.560+09	3.422+05	1.229+05
22	7.920+09	7.099-01	3.927+10	5.522+02	1.409+00	2.400+00	7.920+09	7.920+09	3.474+05	1.258+05
23	8.280+09	7.068-01	4.073+10	5.625+02	1.415+00	2.400+00	8.280+09	8.280+09	3.524+05	1.287+05
24	8.640+09	7.037-01	4.219+10	5.728+02	1.421+00	2.400+00	8.640+09	8.640+09	3.573+05	1.314+05
25	9.000+09	7.008-01	4.364+10	5.831+02	1.427+00	2.400+00	9.000+09	9.000+09	3.621+05	1.341+05
26	9.360+09	6.980-01	4.508+10	5.934+02	1.433+00	2.400+00	9.360+09	9.360+09	3.668+05	1.368+05
27	9.720+09	6.953-01	4.651+10	6.036+02	1.438+00	2.400+00	9.720+09	9.720+09	3.713+05	1.394+05
28	1.008+10	6.926-01	4.793+10	6.138+02	1.444+00	2.400+00	1.008+10	1.008+10	3.758+05	1.420+05
29	1.044+10	6.901-01	4.934+10	6.240+02	1.449+00	2.400+00	1.044+10	1.044+10	3.802+05	1.445+05
30	1.080+10	6.877-01	5.075+10	6.342+02	1.454+00	2.400+00	1.080+10	1.080+10	3.845+05	1.469+05
31	1.116+10	6.853-01	5.215+10	6.444+02	1.459+00	2.400+00	1.116+10	1.116+10	3.886+05	1.494+05
32	1.152+10	6.830-01	5.355+10	6.546+02	1.464+00	2.400+00	1.152+10	1.152+10	3.928+05	1.518+05
33	1.188+10	6.808-01	5.494+10	6.648+02	1.469+00	2.400+00	1.188+10	1.188+10	3.968+05	1.541+05
34	1.224+10	6.786-01	5.632+10	6.749+02	1.474+00	2.400+00	1.224+10	1.224+10	4.008+05	1.564+05
35	1.260+10	6.765-01	5.770+10	6.851+02	1.478+00	2.400+00	1.260+10	1.260+10	4.046+05	1.587+05
36	1.296+10	6.744-01	5.907+10	6.952+02	1.483+00	2.400+00	1.296+10	1.296+10	4.085+05	1.610+05
37	1.332+10	6.724-01	6.044+10	7.054+02	1.487+00	2.400+00	1.332+10	1.332+10	4.122+05	1.632+05
38	1.368+10	6.705-01	6.180+10	7.155+02	1.491+00	2.400+00	1.368+10	1.368+10	4.159+05	1.654+05
39	1.404+10	6.686-01	6.316+10	7.256+02	1.496+00	2.400+00	1.404+10	1.404+10	4.196+05	1.676+05
40	1.440+10	6.668-01	6.451+10	7.357+07	1.500+00	2.400+00	1.440+10	1.440+10	4.232+05	1.697+05
41	1.476+10	6.650-01	6.586+10	7.458+02	1.504+00	2.400+00	1.476+10	1.476+10	4.267+05	1.718+05
42	1.512+10	6.632-01	6.720+10	7.560+02	1.508+00	2.400+00	1.512+10	1.512+10	4.302+05	1.739+05
43	1.548+10	6.615-01	6.854+10	7.661+02	1.512+00	2.400+00	1.548+10	1.548+10	4.336+05	1.759+05
44	1.584+10	6.598-01	6.987+10	7.761+02	1.516+00	2.400+00	1.584+10	1.584+10	4.370+05	1.780+05
45	1.620+10	6.581-01	7.120+10	7.862+02	1.519+00	2.400+00	1.620+10	1.620+10	4.403+05	1.800+05
46	1.656+10	6.565-01	7.253+10	7.963+02	1.523+00	2.400+00	1.656+10	1.656+10	4.436+05	1.820+05
47	1.692+10	6.549-01	7.385+10	8.064+02	1.527+00	2.400+00	1.692+10	1.692+10	4.469+05	1.839+05
48	1.728+10	6.534-01	7.516+10	8.165+02	1.530+00	2.400+00	1.728+10	1.728+10	4.501+05	1.859+05
49	1.764+10	6.519-01	7.648+10	8.266+02	1.534+00	2.400+00	1.764+10	1.764+10	4.533+05	1.878+05

TABLE B.5 (Continued)

100 Percent Water, 10 Percent Porosity Mixture (Continued)

50	1.800+10	6.504-01	7.779+10	8.366+02	1.538+00	2.400+00	1.800+10	1.800+10	4.564+05	1.897+05
51	1.836+10	6.489-01	7.910+10	8.467+02	1.541+00	2.400+00	1.836+10	1.836+10	4.595+05	1.916+05
52	1.872+10	6.475-01	8.040+10	8.568+02	1.544+00	2.400+00	1.872+10	1.872+10	4.625+05	1.935+05
53	1.908+10	6.461-01	8.170+10	8.668+02	1.548+00	2.400+00	1.908+10	1.908+10	4.656+05	1.953+05
54	1.944+10	6.447-01	8.300+10	8.769+02	1.551+00	2.400+00	1.944+10	1.944+10	4.686+05	1.972+05
55	1.980+10	6.434-01	8.429+10	8.869+02	1.554+00	2.400+00	1.980+10	1.980+10	4.715+05	1.990+05
56	2.016+10	6.420-01	8.558+10	8.970+02	1.558+00	2.400+00	2.016+10	2.016+10	4.744+05	2.008+05
57	2.052+10	6.407-01	8.687+10	9.070+02	1.561+00	2.400+00	2.052+10	2.052+10	4.773+05	2.026+05
58	2.088+10	6.394-01	8.815+10	9.171+02	1.564+00	2.400+00	2.088+10	2.088+10	4.802+05	2.043+05
59	2.124+10	6.382-01	8.943+10	9.271+02	1.567+00	2.400+00	2.124+10	2.124+10	4.830+05	2.061+05
60	2.160+10	6.369-01	9.071+10	9.372+02	1.570+00	2.400+00	2.160+10	2.160+10	4.858+05	2.078+05
61	2.196+10	6.357-01	9.198+10	9.472+02	1.573+00	2.400+00	2.196+10	2.196+10	4.886+05	2.096+05
62	2.232+10	6.345-01	9.326+10	9.572+02	1.576+00	2.400+00	2.232+10	2.232+10	4.913+05	2.113+05
63	2.268+10	6.333-01	9.452+10	9.673+02	1.579+00	2.400+00	2.268+10	2.268+10	4.941+05	2.130+05
64	2.304+10	6.321-01	9.579+10	9.773+02	1.582+00	2.400+00	2.304+10	2.304+10	4.967+05	2.147+05
65	2.340+10	6.310-01	9.706+10	9.873+02	1.585+00	2.400+00	2.340+10	2.340+10	4.994+05	2.163+05
66	2.376+10	6.298-01	9.832+10	9.974+02	1.588+00	2.400+00	2.376+10	2.376+10	5.021+05	2.180+05
67	2.412+10	6.287-01	9.958+10	1.007+03	1.591+00	2.400+00	2.412+10	2.412+10	5.047+05	2.196+05
68	2.448+10	6.276-01	1.008+11	1.017+03	1.593+00	2.400+00	2.448+10	2.448+10	5.073+05	2.213+05
69	2.484+10	6.265-01	1.021+11	1.027+03	1.596+00	2.400+00	2.484+10	2.484+10	5.098+05	2.229+05
70	2.520+10	6.254-01	1.033+11	1.037+03	1.599+00	2.400+00	2.520+10	2.520+10	5.124+05	2.245+05
71	2.556+10	6.244-01	1.046+11	1.047+03	1.602+00	2.400+00	2.556+10	2.556+10	5.149+05	2.261+05
72	2.592+10	6.233-01	1.058+11	1.057+03	1.604+00	2.400+00	2.592+10	2.592+10	5.174+05	2.277+05
73	2.628+10	6.223-01	1.071+11	1.068+03	1.607+00	2.400+00	2.628+10	2.628+10	5.199+05	2.292+05
74	2.664+10	6.213-01	1.083+11	1.078+03	1.610+00	2.400+00	2.664+10	2.664+10	5.224+05	2.308+05
75	2.700+10	6.203-01	1.096+11	1.088+03	1.612+00	2.400+00	2.700+10	2.700+10	5.248+05	2.324+05
76	2.736+10	6.193-01	1.108+11	1.098+03	1.615+00	2.400+00	2.736+10	2.736+10	5.272+05	2.339+05
77	2.772+10	6.183-01	1.120+11	1.108+03	1.617+00	2.400+00	2.772+10	2.772+10	5.297+05	2.354+05
78	2.808+10	6.173-01	1.133+11	1.118+03	1.620+00	2.400+00	2.808+10	2.808+10	5.320+05	2.370+05
79	2.844+10	6.164-01	1.145+11	1.128+03	1.622+00	2.400+00	2.844+10	2.844+10	5.344+05	2.385+05
80	2.880+10	6.154-01	1.157+11	1.138+03	1.625+00	2.400+00	2.880+10	2.880+10	5.368+05	2.400+05
81	2.916+10	6.145-01	1.170+11	1.148+03	1.627+00	2.400+00	2.916+10	2.916+10	5.391+05	2.415+05
82	2.952+10	6.136-01	1.182+11	1.158+03	1.630+00	2.400+00	2.952+10	2.952+10	5.414+05	2.430+05
83	2.988+10	6.127-01	1.194+11	1.168+03	1.632+00	2.400+00	2.988+10	2.988+10	5.437+05	2.444+05
84	3.024+10	6.118-01	1.206+11	1.178+03	1.635+00	2.400+00	3.024+10	3.024+10	5.460+05	2.459+05
85	3.060+10	6.109-01	1.218+11	1.188+03	1.637+00	2.400+00	3.060+10	3.060+10	5.482+05	2.474+05
86	3.096+10	6.100-01	1.231+11	1.198+03	1.639+00	2.400+00	3.096+10	3.096+10	5.505+05	2.488+05
87	3.132+10	6.091-01	1.243+11	1.208+03	1.642+00	2.400+00	3.132+10	3.132+10	5.527+05	2.503+05
88	3.168+10	6.082-01	1.255+11	1.218+03	1.644+00	2.400+00	3.168+10	3.168+10	5.549+05	2.517+05
89	3.204+10	6.074-01	1.267+11	1.228+03	1.646+00	2.400+00	3.204+10	3.204+10	5.571+05	2.531+05
90	3.240+10	6.065-01	1.279+11	1.238+03	1.649+00	2.400+00	3.240+10	3.240+10	5.593+05	2.545+05
91	3.276+10	6.065-01	1.287+11	1.249+03	1.649+00	2.400+00	3.276+10	3.276+10	5.610+05	2.553+05
92	3.312+10	6.049-01	1.303+11	1.258+03	1.653+00	2.400+00	3.312+10	3.312+10	5.636+05	2.573+05
93	3.348+10	6.041-01	1.315+11	1.268+03	1.655+00	2.400+00	3.348+10	3.348+10	5.658+05	2.588+05
94	3.384+10	6.041-01	1.323+11	1.279+03	1.655+00	2.400+00	3.384+10	3.384+10	5.675+05	2.595+05
95	3.420+10	6.025-01	1.339+11	1.288+03	1.660+00	2.400+00	3.420+10	3.420+10	5.700+05	2.615+05
96	3.456+10	6.025-01	1.347+11	1.299+03	1.660+00	2.400+00	3.456+10	3.456+10	5.717+05	2.623+05
97	3.492+10	6.009-01	1.363+11	1.308+03	1.664+00	2.400+00	3.492+10	3.492+10	5.742+05	2.642+05
98	3.528+10	6.009-01	1.371+11	1.319+03	1.664+00	2.400+00	3.528+10	3.528+10	5.759+05	2.650+05
99	3.564+10	5.993-01	1.387+11	1.328+03	1.669+00	2.400+00	3.564+10	3.564+10	5.783+05	2.669+05
100	3.600+10	5.993-01	1.395+11	1.339+03	1.669+00	2.400+00	3.600+10	3.600+10	5.800+05	2.677+05
101	3.636+10	5.978-01	1.411+11	1.348+03	1.673+00	2.400+00	3.636+10	3.636+10	5.824+05	2.696+05
102	3.672+10	5.978-01	1.419+11	1.359+03	1.673+00	2.400+00	3.672+10	3.672+10	5.841+05	2.704+05
103	3.708+10	5.963-01	1.435+11	1.368+03	1.677+00	2.400+00	3.708+10	3.708+10	5.865+05	2.723+05

TABLE B.5 (Continued)

100 Percent Water, 10 Percent Porosity Mixture (Continued)

104	3.744+10	5.963-01	1.443+11	1.379+03	1.677+00	2.400+00	3.744+10	3.744+10	5.881+05	2.730+05
105	3.780+10	5.948-01	1.458+11	1.388+03	1.681+00	2.400+00	3.780+10	3.780+10	5.905+05	2.749+05
106	3.816+10	5.948-01	1.466+11	1.399+03	1.681+00	2.400+00	3.816+10	3.816+10	[illegible]	2.757+05
107	3.852+10	5.934-01	1.482+11	1.408+03	1.685+00	2.400+00	3.852+10	3.852+10	[illegible]	2.775+05
108	3.888+10	5.934-01	1.490+11	1.419+03	1.685+00	2.400+00	3.888+10	3.888+10	[illegible]	2.783+05
109	3.924+10	5.920-01	1.506+11	1.427+03	1.689+00	2.400+00	3.924+10	3.924+10	5.983+05	2.801+05
110	3.960+10	5.920-01	1.513+11	1.438+03	1.689+00	2.400+00	3.960+10	3.960+10	5.999+05	2.808+05
111	3.996+10	5.906-01	1.529+11	1.447+03	1.693+00	2.400+00	3.996+10	3.996+10	6.022+05	2.827+05
112	4.032+10	5.906-01	1.537+11	1.458+03	1.693+00	2.400+00	4.032+10	4.032+10	6.037+05	2.834+05
113	4.068+10	5.892-01	1.553+11	1.467+03	1.697+00	2.400+00	4.068+10	4.068+10	6.060+05	2.852+05
114	4.104+10	5.892-01	1.561+11	1.478+03	1.697+00	2.400+00	4.104+10	4.104+10	6.075+05	2.859+05
115	4.140+10	5.879-01	1.576+11	1.487+03	[illegible]	2.400+00	4.140+10	4.140+10	6.097+05	2.877+05
116	4.176+10	5.879-01	1.584+11	1.498+03	1.701+00	2.400+00	4.176+10	4.176+10	6.113+05	2.884+05
117	4.212+10	5.865-01	1.599+11	1.507+03	1.705+00	2.400+00	4.212+10	4.212+10	6.135+05	2.902+05
118	4.248+10	5.865-01	1.607+11	1.518+03	1.705+00	2.400+00	4.248+10	4.248+10	6.150+05	2.909+05
119	4.284+10	5.852-01	1.623+11	1.527+03	1.709+00	2.400+00	4.284+10	4.284+10	6.172+05	2.927+05
120	4.320+10	5.852-01	1.631+11	1.538+03	1.709+00	2.400+00	4.320+10	4.320+10	6.187+05	2.934+05
121	4.356+10	5.839-01	1.646+11	1.547+03	1.712+00	2.400+00	4.356+10	4.356+10	6.208+05	2.951+05
122	4.392+10	5.839-01	1.654+11	1.558+03	1.712+00	2.400+00	4.392+10	4.392+10	6.223+05	2.958+05
123	4.428+10	5.827-01	1.669+11	1.567+03	1.716+00	2.400+00	4.428+10	4.428+10	6.244+05	2.976+05
124	4.464+10	5.827-01	1.677+11	1.578+03	1.716+00	2.400+00	4.464+10	4.464+10	6.259+05	2.983+05
125	4.500+10	5.814-01	1.692+11	1.587+03	1.720+00	2.400+00	4.500+10	4.500+10	6.280+05	3.000+05
126	4.536+10	5.814-01	1.700+11	1.598+03	1.720+00	2.400+00	4.536+10	4.536+10	6.295+05	3.007+05
127	4.572+10	5.802-01	1.715+11	1.607+03	1.724+00	2.400+00	4.572+10	4.572+10	6.315+05	3.024+05
128	4.608+10	5.802-01	1.723+11	1.618+03	1.724+00	2.400+00	4.608+10	4.608+10	6.330+05	3.031+05
129	4.644+10	5.790-01	1.739+11	1.627+03	1.727+00	2.400+00	4.644+10	4.644+10	6.351+05	3.047+05
130	4.680+10	5.790-01	1.746+11	1.638+03	1.727+00	2.400+00	4.680+10	4.680+10	6.365+05	3.054+05
131	4.716+10	5.778-01	1.762+11	1.647+03	1.731+00	2.400+00	4.716+10	4.716+10	6.385+05	3.071+05
132	4.752+10	5.778-01	1.769+11	1.658+03	1.731+00	2.400+00	4.752+10	4.752+10	6.400+05	3.078+05
133	4.788+10	5.766-01	1.785+11	1.667+03	1.734+00	2.400+00	4.788+10	4.788+10	6.420+05	3.094+05
134	4.824+10	5.766-01	1.792+11	1.678+03	1.734+00	2.400+00	4.824+10	4.824+10	6.434+05	3.101+05
135	4.860+10	5.755-01	1.807+11	1.687+03	1.738+00	2.400+00	4.860+10	4.860+10	6.454+05	3.117+05
136	4.896+10	5.755-01	1.815+11	1.698+03	1.738+00	2.400+00	4.896+10	4.896+10	6.468+05	3.124+05
137	4.932+10	5.743-01	1.830+11	1.707+03	1.741+00	2.400+00	4.932+10	4.932+10	6.488+05	3.140+05
138	4.968+10	5.743-01	1.838+11	1.718+03	1.741+00	2.400+00	4.968+10	4.968+10	6.502+05	3.147+05
139	5.004+10	5.732-01	1.853+11	1.727+03	1.745+00	2.400+00	5.004+10	5.004+10	6.521+05	3.163+05
140	5.040+10	5.732-01	1.861+11	1.738+03	1.745+00	2.400+00	5.040+10	5.040+10	6.535+05	3.170+05
141	5.076+10	5.721-01	1.876+11	1.747+03	1.748+00	2.400+00	5.076+10	5.076+10	6.554+05	3.186+05
142	5.112+10	5.721-01	1.884+11	1.758+03	1.748+00	2.400+00	5.112+10	5.112+10	6.568+05	3.193+05
143	5.148+10	5.710-01	1.899+11	1.767+03	1.751+00	2.400+00	5.148+10	5.148+10	6.587+05	3.208+05
144	5.184+10	5.710-01	1.907+11	1.778+03	1.751+00	2.400+00	5.184+10	5.184+10	6.601+05	3.215+05
145	5.220+10	5.699-01	1.921+11	1.786+03	1.755+00	2.400+00	5.220+10	5.220+10	6.620+05	3.231+05
146	5.256+10	5.699-01	1.929+11	1.797+03	1.755+00	2.400+00	5.256+10	5.256+10	6.634+05	3.237+05
147	5.292+10	5.688-01	1.944+11	1.806+03	1.758+00	2.400+00	5.292+10	5.292+10	6.652+05	3.253+05
148	5.328+10	5.688-01	1.952+11	1.817+03	1.758+00	2.400+00	5.328+10	5.328+10	6.666+05	3.260+05
149	5.364+10	5.677-01	1.967+11	1.826+03	1.761+00	2.400+00	5.364+10	5.364+10	6.684+05	3.275+05
150	5.400+10	5.677-01	1.975+11	1.837+03	1.761+00	2.400+00	5.400+10	5.400+10	6.698+05	3.282+05
151	5.436+10	5.667-01	1.989+11	1.846+03	1.765+00	2.400+00	5.436+10	5.436+10	6.716+05	3.297+05
152	5.472+10	5.667-01	1.997+11	1.857+03	1.765+00	2.400+00	5.472+10	5.472+10	6.730+05	3.303+05
153	5.508+10	5.657-01	2.012+11	1.866+03	1.768+00	2.400+00	5.508+10	5.508+10	6.748+05	3.319+05
154	5.544+10	5.657-01	2.020+11	1.877+03	1.768+00	2.400+00	5.544+10	5.544+10	6.761+05	3.325+05
155	5.580+10	5.646-01	2.034+11	1.886+03	1.771+00	2.400+00	5.580+10	5.580+10	6.779+05	3.340+05
156	5.616+10	5.646-01	2.042+11	1.897+03	1.771+00	2.400+00	5.616+10	5.616+10	6.792+05	3.347+05
157	5.652+10	5.636-01	2.057+11	1.906+03	1.774+00	2.400+00	5.652+10	5.652+10	6.810+05	3.362+05

TABLE B.5 (Continued)

100 Percent Water, 10 Percent Porosity Mixture (Continued)

158	5.688+10	5.636-01	2.065+11	1.917+03	1.774+00	2.900+00	5.688+10	5.688+10	6.823+05	3.368+05
159	5.724+10	5.626-01	2.079+11	1.926+03	1.777+00	2.900+00	5.724+10	5.724+10	6.841+05	3.383+05
160	5.760+10	5.626-01	2.087+11	1.937+03	1.777+00	2.900+00	5.760+10	5.760+10	6.854+05	3.390+05
161	5.796+10	5.616-01	2.102+11	1.946+03	1.781+00	2.900+00	5.796+10	5.796+10	6.872+05	3.404+05
162	5.832+10	5.616-01	2.109+11	1.957+03	1.781+00	2.900+00	5.832+10	5.832+10	6.884+05	3.411+05
163	5.868+10	5.607-01	2.124+11	1.966+03	1.784+00	2.900+00	5.868+10	5.868+10	6.902+05	3.425+05
164	5.904+10	5.607-01	2.132+11	1.977+03	1.784+00	2.900+00	5.904+10	5.904+10	6.915+05	3.432+05
165	5.940+10	5.607-01	2.140+11	1.988+03	1.784+00	2.900+00	5.940+10	5.940+10	6.927+05	3.438+05
166	5.976+10	5.593-01	2.157+11	1.996+03	1.788+00	2.900+00	5.976+10	5.976+10	6.947+05	3.457+05
167	6.012+10	5.593-01	2.165+11	2.007+03	1.788+00	2.900+00	6.012+10	6.012+10	6.959+05	3.463+05
168	6.048+10	5.583-01	2.180+11	2.015+03	1.791+00	2.900+00	6.048+10	6.048+10	6.977+05	3.478+05
169	6.084+10	5.583-01	2.188+11	2.026+03	1.791+00	2.900+00	6.084+10	6.084+10	6.989+05	3.484+05
170	6.120+10	5.583-01	2.195+11	2.037+03	1.791+00	2.900+00	6.120+10	6.120+10	7.002+05	3.490+05
171	6.156+10	5.569-01	2.213+11	2.045+03	1.796+00	2.900+00	6.156+10	6.156+10	7.021+05	3.508+05
172	6.192+10	5.569-01	2.221+11	2.056+03	1.796+00	2.900+00	6.192+10	6.192+10	7.033+05	3.514+05
173	6.228+10	5.569-01	2.228+11	2.067+03	1.796+00	2.900+00	6.228+10	6.228+10	7.046+05	3.521+05
174	6.264+10	5.555-01	2.246+11	2.075+03	1.800+00	2.900+00	6.264+10	6.264+10	7.065+05	3.539+05
175	6.300+10	5.555-01	2.254+11	2.086+03	1.800+00	2.900+00	6.300+10	6.300+10	7.077+05	3.545+05
176	6.336+10	5.555-01	2.262+11	2.097+03	1.800+00	2.900+00	6.336+10	6.336+10	7.089+05	3.551+05
177	6.372+10	5.542-01	2.279+11	2.105+03	1.805+00	2.900+00	6.372+10	6.372+10	7.108+05	3.569+05
178	6.408+10	5.542-01	2.287+11	2.116+03	1.805+00	2.900+00	6.408+10	6.408+10	7.120+05	3.575+05
179	6.444+10	5.542-01	2.295+11	2.127+03	1.805+00	2.900+00	6.444+10	6.444+10	7.132+05	3.581+05
180	6.480+10	5.528-01	2.312+11	2.135+03	1.809+00	2.900+00	6.480+10	6.480+10	7.151+05	3.599+05
181	6.516+10	5.528-01	2.320+11	2.146+03	1.809+00	2.900+00	6.516+10	6.516+10	7.163+05	3.605+05
182	6.552+10	5.528-01	2.328+11	2.157+03	1.809+00	2.900+00	6.552+10	6.552+10	7.175+05	3.611+05
183	6.588+10	5.515-01	2.345+11	2.165+03	1.813+00	2.900+00	6.588+10	6.588+10	7.193+05	3.629+05
184	6.624+10	5.515-01	2.353+11	2.176+03	1.813+00	2.900+00	6.624+10	6.624+10	7.205+05	3.635+05
185	6.660+10	5.515-01	2.361+11	2.187+03	1.813+00	2.900+00	6.660+10	6.660+10	7.217+05	3.641+05
186	6.696+10	5.502-01	2.378+11	2.194+03	1.818+00	2.900+00	6.696+10	6.696+10	7.235+05	3.659+05
187	6.732+10	5.502-01	2.386+11	2.206+03	1.818+00	2.900+00	6.732+10	6.732+10	7.247+05	3.665+05
188	6.768+10	5.502-01	2.394+11	2.217+03	1.818+00	2.900+00	6.768+10	6.768+10	7.259+05	3.671+05
189	6.804+10	5.489-01	2.411+11	2.224+03	1.822+00	2.900+00	6.804+10	6.804+10	7.277+05	3.688+05
190	6.840+10	5.489-01	2.419+11	2.235+03	1.822+00	2.900+00	6.840+10	6.840+10	7.288+05	3.694+05
191	6.876+10	5.489-01	2.427+11	2.246+03	1.822+00	2.900+00	6.876+10	6.876+10	7.300+05	3.700+05
192	6.912+10	5.477-01	2.444+11	2.254+03	1.826+00	2.900+00	6.912+10	6.912+10	7.318+05	3.717+05
193	6.948+10	5.477-01	2.452+11	2.265+03	1.826+00	2.900+00	6.948+10	6.948+10	7.329+05	3.723+05
194	6.984+10	5.477-01	2.459+11	2.276+03	1.826+00	2.900+00	6.984+10	6.984+10	7.341+05	3.729+05
195	7.020+10	5.464-01	2.477+11	2.284+03	1.830+00	2.900+00	7.020+10	7.020+10	7.359+05	3.746+05
196	7.056+10	5.464-01	2.484+11	2.295+03	1.830+00	2.900+00	7.056+10	7.056+10	7.370+05	3.752+05
197	7.092+10	5.464-01	2.492+11	2.306+03	1.830+00	2.900+00	7.092+10	7.092+10	7.382+05	3.758+05
198	7.128+10	5.452-01	2.509+11	2.314+03	1.834+00	2.900+00	7.128+10	7.128+10	7.399+05	3.775+05
199	7.164+10	5.452-01	2.517+11	2.325+03	1.834+00	2.900+00	7.164+10	7.164+10	7.410+05	3.781+05
200	7.200+10	5.452-01	2.525+11	2.336+03	1.834+00	2.900+00	7.200+10	7.200+10	7.422+05	3.787+05
201	7.236+10	5.440-01	2.542+11	2.344+03	1.838+00	2.900+00	7.236+10	7.236+10	7.439+05	3.804+05
202	7.272+10	5.440-01	2.550+11	2.355+03	1.838+00	2.900+00	7.272+10	7.272+10	7.450+05	3.809+05
203	7.308+10	5.440-01	2.557+11	2.366+03	1.838+00	2.900+00	7.308+10	7.308+10	7.462+05	3.815+05
204	7.344+10	5.428-01	2.574+11	2.373+03	1.842+00	2.900+00	7.344+10	7.344+10	7.478+05	3.832+05
205	7.380+10	5.428-01	2.582+11	2.384+03	1.842+00	2.900+00	7.380+10	7.380+10	7.490+05	3.838+05
206	7.416+10	5.428-01	2.590+11	2.395+03	1.842+00	2.900+00	7.416+10	7.416+10	7.501+05	3.843+05
207	7.452+10	5.416-01	2.607+11	2.403+03	1.846+00	2.900+00	7.452+10	7.452+10	7.518+05	3.860+05
208	7.488+10	5.416-01	2.615+11	2.414+03	1.846+00	2.900+00	7.488+10	7.488+10	7.529+05	3.866+05
209	7.524+10	5.416-01	2.622+11	2.425+03	1.846+00	2.900+00	7.524+10	7.524+10	7.540+05	3.871+05
210	7.560+10	5.404-01	2.639+11	2.433+03	1.850+00	2.900+00	7.560+10	7.560+10	7.557+05	3.888+05
211	7.596+10	5.404-01	2.647+11	2.444+03	1.850+00	2.900+00	7.596+10	7.596+10	7.568+05	3.893+05

TABLE B.5 (Continued)

100 Percent Water, 10 Percent Porosity Mixture (Continued)

212	7.632+10	5.409-01	2.655+11	2.455+03	1.850+00	2.400+00	7.632+10	7.632+10	7.579+05	3.899+05
213	7.668+10	5.393-01	2.672+11	2.463+03	1.854+00	2.400+00	7.668+10	7.668+10	7.595+05	3.915+05
214	7.704+10	5.393-01	2.679+11	2.474+03	1.854+00	2.400+00	7.704+10	7.704+10	7.606+05	3.921+05
215	7.740+10	5.393-01	2.687+11	2.485+03	1.854+00	2.400+00	7.740+10	7.740+10	7.617+05	3.927+05
216	7.776+10	5.382-01	2.704+11	2.492+03	1.858+00	2.400+00	7.776+10	7.776+10	7.633+05	3.943+05
217	7.812+10	5.382-01	2.712+11	2.503+03	1.858+00	2.400+00	7.812+10	7.812+10	7.644+05	3.949+05
218	7.848+10	5.382-01	2.719+11	2.515+03	1.858+00	2.400+00	7.848+10	7.848+10	7.655+05	3.954+05
219	7.884+10	5.370-01	2.736+11	2.522+03	1.862+00	2.400+00	7.884+10	7.884+10	7.671+05	3.970+05
220	7.920+10	5.370-01	2.744+11	2.533+03	1.862+00	2.400+00	7.920+10	7.920+10	7.682+05	3.976+05
221	7.956+10	5.370-01	2.752+11	2.544+03	1.862+00	2.400+00	7.956+10	7.956+10	7.693+05	3.981+05
222	7.992+10	5.359-01	2.768+11	2.552+03	1.866+00	2.400+00	7.992+10	7.992+10	7.709+05	3.997+05
223	8.028+10	5.359-01	2.776+11	2.563+03	1.866+00	2.400+00	8.028+10	8.028+10	7.720+05	4.003+05
224	8.064+10	5.359-01	2.784+11	2.574+03	1.866+00	2.400+00	8.064+10	8.064+10	7.730+05	4.008+05
225	8.100+10	5.348-01	2.800+11	2.582+03	1.870+00	2.400+00	8.100+10	8.100+10	7.746+05	4.024+05
226	8.136+10	5.348-01	2.808+11	2.593+03	1.870+00	2.400+00	8.136+10	8.136+10	7.757+05	4.030+05
227	8.172+10	5.348-01	2.816+11	2.604+03	1.870+00	2.400+00	8.172+10	8.172+10	7.767+05	4.035+05
228	8.208+10	5.338-01	2.833+11	2.612+03	1.874+00	2.400+00	8.208+10	8.208+10	7.783+05	4.051+05
229	8.244+10	5.338-01	2.840+11	2.623+03	1.874+00	2.400+00	8.244+10	8.244+10	7.794+05	4.056+05
230	8.280+10	5.338-01	2.848+11	2.634+03	1.874+00	2.400+00	8.280+10	8.280+10	7.804+05	4.062+05
231	8.316+10	5.327-01	2.865+11	2.641+03	1.877+00	2.400+00	8.316+10	8.316+10	7.820+05	4.078+05
232	8.352+10	5.327-01	2.872+11	2.652+03	1.877+00	2.400+00	8.352+10	8.352+10	7.830+05	4.083+05
233	8.388+10	5.327-01	2.880+11	2.663+03	1.877+00	2.400+00	8.388+10	8.388+10	7.841+05	4.088+05
234	8.424+10	5.316-01	2.896+11	2.671+03	1.881+00	2.400+00	8.424+10	8.424+10	7.856+05	4.104+05
235	8.460+10	5.316-01	2.904+11	2.682+03	1.881+00	2.400+00	8.460+10	8.460+10	7.867+05	4.109+05
236	8.496+10	5.316-01	2.912+11	2.693+03	1.881+00	2.400+00	8.496+10	8.496+10	7.877+05	4.115+05
237	8.532+10	5.306-01	2.928+11	2.701+03	1.885+00	2.400+00	8.532+10	8.532+10	7.892+05	4.130+05
238	8.568+10	5.306-01	2.936+11	2.712+03	1.885+00	2.400+00	8.568+10	8.568+10	7.903+05	4.136+05
239	8.604+10	5.306-01	2.944+11	2.723+03	1.885+00	2.400+00	8.604+10	8.604+10	7.913+05	4.141+05
240	8.640+10	5.296-01	2.960+11	2.731+03	1.888+00	2.400+00	8.640+10	8.640+10	7.928+05	4.156+05
241	8.676+10	5.296-01	2.968+11	2.742+03	1.888+00	2.400+00	8.676+10	8.676+10	7.938+05	4.162+05
242	8.712+10	5.296-01	2.976+11	2.753+03	1.888+00	2.400+00	8.712+10	8.712+10	7.949+05	4.167+05
243	8.748+10	5.286-01	2.992+11	2.760+03	1.892+00	2.400+00	8.748+10	8.748+10	7.969+05	4.182+05
244	8.784+10	5.286-01	3.000+11	2.771+03	1.892+00	2.400+00	8.784+10	8.784+10	7.979+05	4.187+05
245	8.820+10	5.286-01	3.007+11	2.782+03	1.892+00	2.400+00	8.820+10	8.820+10	7.984+05	4.193+05

TABLE B.5 (Continued)

100 PERCENT WATER, 5 PERCENT POROSITY MIXTURE

K	AIX	TVOL	P	THETA	RHO WATER	RHO TUFF	SIE WATER	SIE TUFF	SHOCK VEL.	PART. VEL.
1	3.600+08	8.870-01	4.306+09	3.192+02	1.127+00	2.400+00	3.600+08	3.600+08	1.691+05	2.686+04
2	7.200+08	8.509-01	7.050+09	3.339+02	1.176+00	2.400+00	7.200+08	7.200+08	1.960+05	3.793+04
3	1.080+09	8.269-01	9.467+09	3.468+02	1.209+00	2.400+00	1.080+09	1.080+09	2.150+05	4.643+04
4	1.440+09	8.091-01	1.173+10	3.590+02	1.236+00	2.400+00	1.440+09	1.440+09	2.305+05	5.365+04
5	1.800+09	7.946-01	1.390+10	3.706+02	1.259+00	2.400+00	1.800+09	1.800+09	2.439+05	6.012+04
6	2.160+09	7.829-01	1.593+10	3.819+02	1.277+00	2.400+00	2.160+09	2.160+09	2.559+05	6.577+04
7	2.520+09	7.732-01	1.784+10	3.930+02	1.293+00	2.400+00	2.520+09	2.520+09	2.655+05	7.084+04
8	2.880+09	7.639-01	1.981+10	4.038+02	1.309+00	2.400+00	2.880+09	2.880+09	2.754+05	7.588+04
9	3.240+09	7.560-01	2.169+10	4.146+02	1.323+00	2.400+00	3.240+09	3.240+09	2.842+05	8.047+04
10	3.600+09	7.488-01	2.353+10	4.252+02	1.336+00	2.400+00	3.600+09	3.600+09	2.925+05	8.482+04
11	3.960+09	7.422-01	2.534+10	4.357+02	1.347+00	2.400+00	3.960+09	3.960+09	3.003+05	8.896+04
12	4.320+09	7.361-01	2.711+10	4.462+02	1.358+00	2.400+00	4.320+09	4.320+09	3.077+05	9.291+04
13	4.680+09	7.305-01	2.887+10	4.565+02	1.369+00	2.400+00	4.680+09	4.680+09	3.148+05	9.671+04
14	5.040+09	7.253-01	3.059+10	4.668+02	1.379+00	2.400+00	5.040+09	5.040+09	3.215+05	1.004+05
15	5.400+09	7.204-01	3.230+10	4.771+02	1.388+00	2.400+00	5.400+09	5.400+09	3.279+05	1.039+05
16	5.760+09	7.158-01	3.399+10	4.873+02	1.397+00	2.400+00	5.760+09	5.760+09	3.341+05	1.073+05
17	6.120+09	7.115-01	3.566+10	4.974+02	1.405+00	2.400+00	6.120+09	6.120+09	3.400+05	1.106+05
18	6.480+09	7.075-01	3.731+10	5.076+02	1.414+00	2.400+00	6.480+09	6.480+09	3.457+05	1.138+05
19	6.840+09	7.035-01	3.895+10	5.177+02	1.421+00	2.400+00	6.840+09	6.840+09	3.513+05	1.169+05
20	7.200+09	6.99[illegible]-01	4.057+10	5.277+02	1.429+00	2.400+00	7.200+09	7.200+09	3.566+05	1.200+05
21	7.560+09	6.963-01	4.218+10	5.377+02	1.436+00	2.400+00	7.560+09	7.560+09	3.618+05	1.229+05
22	7.920+09	6.929-01	4.378+10	5.477+02	1.443+00	2.400+00	7.920+09	7.920+09	3.669+05	1.258+05
23	8.280+09	6.897-01	4.536+10	5.577+02	1.450+00	2.400+00	8.280+09	8.280+09	3.718+05	1.287+05
24	8.640+09	6.865-01	4.694+10	5.677+02	1.457+00	2.400+00	8.640+09	8.640+09	3.766+05	1.314+05
25	9.000+09	6.836-01	4.850+10	5.776+02	1.463+00	2.400+00	9.000+09	9.000+09	3.813+05	1.341+05
26	9.360+09	6.807-01	5.005+10	5.876+02	1.469+00	2.400+00	9.360+09	9.360+09	3.859+05	1.368+05
27	9.720+09	6.779-01	5.160+10	5.975+02	1.475+00	2.400+00	9.720+09	9.720+09	3.903+05	1.394+05
28	1.008+10	6.752-01	5.313+10	6.074+02	1.481+00	2.400+00	1.008+10	1.008+10	3.947+05	1.420+05
29	1.044+10	6.726-01	5.465+10	6.173+02	1.487+00	2.400+00	1.044+10	1.044+10	3.989+05	1.445+05
30	1.080+10	6.701-01	5.617+10	6.271+02	1.492+00	2.400+00	1.080+10	1.080+10	4.031+05	1.469+05
31	1.116+10	6.677-01	5.768+10	6.370+02	1.498+00	2.400+00	1.116+10	1.116+10	4.072+05	1.494+05
32	1.152+10	6.654-01	5.918+10	6.468+02	1.503+00	2.400+00	1.152+10	1.152+10	4.112+05	1.518+05
33	1.188+10	6.631-01	6.068+10	6.567+02	1.508+00	2.400+00	1.188+10	1.188+10	4.152+05	1.541+05
34	1.224+10	6.608-01	6.216+10	6.665+02	1.513+00	2.400+00	1.224+10	1.224+10	4.190+05	1.564+05
35	1.260+10	6.587-01	6.364+10	6.763+02	1.518+00	2.400+00	1.260+10	1.260+10	4.228+05	1.587+05
36	1.296+10	6.566-01	6.512+10	6.861+02	1.523+00	2.400+00	1.296+10	1.296+10	4.266+05	1.610+05
37	1.332+10	6.545-01	6.658+10	6.959+02	1.528+00	2.400+00	1.332+10	1.332+10	4.302+05	1.632+05
38	1.368+10	6.525-01	6.804+10	7.057+02	1.532+00	2.400+00	1.368+10	1.368+10	4.339+05	1.654+05
39	1.404+10	6.506-01	6.950+10	7.155+02	1.537+00	2.400+00	1.404+10	1.404+10	4.374+05	1.675+05
40	1.440+10	6.487-01	7.095+10	7.253+02	1.542+00	2.400+00	1.440+10	1.440+10	4.409+05	1.697+05
41	1.476+10	6.468-01	7.239+10	7.350+02	1.546+00	2.400+00	1.476+10	1.476+10	4.444+05	1.718+05
42	1.512+10	6.450-01	7.383+10	7.448+02	1.550+00	2.400+00	1.512+10	1.512+10	4.478+05	1.739+05
43	1.548+10	6.433-01	7.526+10	7.545+02	1.555+00	2.400+00	1.548+10	1.548+10	4.511+05	1.759+05
44	1.584+10	6.415-01	7.669+10	7.643+02	1.559+00	2.400+00	1.584+10	1.584+10	4.544+05	1.780+05
45	1.620+10	6.398-01	7.811+10	7.740+02	1.563+00	2.400+00	1.620+10	1.620+10	4.577+05	1.800+05
46	1.656+10	6.382-01	7.953+10	7.838+02	1.567+00	2.400+00	1.656+10	1.656+10	4.609+05	1.820+05
47	1.692+10	6.366-01	8.094+10	7.935+02	1.571+00	2.400+00	1.692+10	1.692+10	4.641+05	1.839+05
48	1.728+10	6.350-01	8.235+10	8.033+02	1.575+00	2.400+00	1.728+10	1.728+10	4.672+05	1.859+05
49	1.764+10	6.334-01	8.376+10	8.130+02	1.579+00	2.400+00	1.764+10	1.764+10	4.703+05	1.878+05

TABLE B.5 (Continued)

100 Percent Water, 5 Percent Porosity Mixture (Continued)

50	1.800+10	6.319-01	8.516+10	8.227+02	1.583+00	2.400+00	1.800+10	1.800+10	4.733+05	1.897+05
51	1.836+10	6.304-01	8.655+10	8.324+02	1.586+00	2.400+00	1.836+10	1.836+10	4.764+05	1.916+05
52	1.872+10	6.289-01	8.795+10	8.422+02	1.590+00	2.400+00	1.872+10	1.872+10	4.793+05	1.935+05
53	1.908+10	6.274-01	8.933+10	8.519+02	1.594+00	2.400+00	1.908+10	1.908+10	4.823+05	1.953+05
54	1.944+10	6.260-01	9.072+10	8.616+02	1.597+00	2.400+00	1.944+10	1.944+10	4.852+05	1.972+05
55	1.980+10	6.246-01	9.210+10	8.713+02	1.601+00	2.400+00	1.980+10	1.980+10	4.881+05	1.990+05
56	2.016+10	6.233-01	9.347+10	8.810+02	1.604+00	2.400+00	2.016+10	2.016+10	4.909+05	2.008+05
57	2.052+10	6.219-01	9.485+10	8.907+02	1.608+00	2.400+00	2.052+10	2.052+10	4.938+05	2.026+05
58	2.088+10	6.206-01	9.622+10	9.004+02	1.611+00	2.400+00	2.088+10	2.088+10	4.965+05	2.043+05
59	2.124+10	6.193-01	9.758+10	9.101+02	1.615+00	2.400+00	2.124+10	2.124+10	4.993+05	2.061+05
60	2.160+10	6.180-01	9.894+10	9.198+02	1.618+00	2.400+00	2.160+10	2.160+10	5.020+05	2.078+05
61	2.196+10	6.167-01	1.003+11	9.295+02	1.621+00	2.400+00	2.196+10	2.196+10	5.047+05	2.096+05
62	2.232+10	6.155-01	1.017+11	9.392+02	1.625+00	2.400+00	2.232+10	2.232+10	5.074+05	2.113+05
63	2.268+10	6.142-01	1.030+11	9.489+02	1.628+00	2.400+00	2.268+10	2.268+10	5.101+05	2.130+05
64	2.304+10	6.130-01	1.044+11	9.586+02	1.631+00	2.400+00	2.304+10	2.304+10	5.127+05	2.146+05
65	2.340+10	6.119-01	1.057+11	9.682+02	1.634+00	2.400+00	2.340+10	2.340+10	5.153+05	2.163+05
66	2.376+10	6.107-01	1.070+11	9.779+02	1.638+00	2.400+00	2.376+10	2.376+10	5.179+05	2.180+05
67	2.412+10	6.095-01	1.084+11	9.876+02	1.641+00	2.400+00	2.412+10	2.412+10	5.204+05	2.196+05
68	2.448+10	6.084-01	1.097+11	9.973+02	1.644+00	2.400+00	2.448+10	2.448+10	5.230+05	2.213+05
69	2.484+10	6.073-01	1.111+11	1.007+03	1.647+00	2.400+00	2.484+10	2.484+10	5.255+05	2.229+05
70	2.520+10	6.062-01	1.124+11	1.017+03	1.650+00	2.400+00	2.520+10	2.520+10	5.280+05	2.245+05
71	2.556+10	6.051-01	1.137+11	1.026+03	1.653+00	2.400+00	2.556+10	2.556+10	5.304+05	2.261+05
72	2.592+10	6.040-01	1.150+11	1.036+03	1.656+00	2.400+00	2.592+10	2.592+10	5.329+05	2.277+05
73	2.628+10	6.029-01	1.164+11	1.046+03	1.659+00	2.400+00	2.628+10	2.628+10	5.353+05	2.292+05
74	2.664+10	6.019-01	1.177+11	1.055+03	1.661+00	2.400+00	2.664+10	2.664+10	5.377+05	2.308+05
75	2.700+10	6.008-01	1.190+11	1.065+03	1.664+00	2.400+00	2.700+10	2.700+10	5.401+05	2.324+05
76	2.736+10	5.998-01	1.203+11	1.075+03	1.667+00	2.400+00	2.736+10	2.736+10	5.425+05	2.339+05
77	2.772+10	5.988-01	1.216+11	1.084+03	1.670+00	2.400+00	2.772+10	2.772+10	5.448+05	2.354+05
78	2.808+10	5.978-01	1.229+11	1.094+03	1.673+00	2.400+00	2.808+10	2.808+10	5.471+05	2.370+05
79	2.844+10	5.968-01	1.243+11	1.104+03	1.676+00	2.400+00	2.844+10	2.844+10	5.494+05	2.385+05
80	2.880+10	5.958-01	1.256+11	1.113+03	1.678+00	2.400+00	2.880+10	2.880+10	5.517+05	2.400+05
81	2.916+10	5.949-01	1.269+11	1.123+03	1.681+00	2.400+00	2.916+10	2.916+10	5.540+05	2.415+05
82	2.952+10	5.939-01	1.282+11	1.133+03	1.684+00	2.400+00	2.952+10	2.952+10	5.563+05	2.430+05
83	2.988+10	5.930-01	1.295+11	1.142+03	1.686+00	2.400+00	2.988+10	2.988+10	5.585+05	2.444+05
84	3.024+10	5.921-01	1.308+11	1.152+03	1.689+00	2.400+00	3.024+10	3.024+10	5.607+05	2.459+05
85	3.060+10	5.911-01	1.321+11	1.162+03	1.692+00	2.400+00	3.060+10	3.060+10	5.629+05	2.474+05
86	3.096+10	5.902-01	1.333+11	1.171+03	1.694+00	2.400+00	3.096+10	3.096+10	5.651+05	2.488+05
87	3.132+10	5.893-01	1.346+11	1.181+03	1.697+00	2.400+00	3.132+10	3.132+10	5.673+05	2.503+05
88	3.168+10	5.884-01	1.359+11	1.191+03	1.699+00	2.400+00	3.168+10	3.168+10	5.695+05	2.517+05
89	3.204+10	5.876-01	1.372+11	1.200+03	1.702+00	2.400+00	3.204+10	3.204+10	5.716+05	2.531+05
90	3.240+10	5.867-01	1.385+11	1.210+03	1.704+00	2.400+00	3.240+10	3.240+10	5.738+05	2.545+05
91	3.276+10	5.858-01	1.398+11	1.220+03	1.707+00	2.400+00	3.276+10	3.276+10	5.759+05	2.560+05
92	3.312+10	5.850-01	1.411+11	1.229+03	1.709+00	2.400+00	3.312+10	3.312+10	5.780+05	2.574+05
93	3.348+10	5.841-01	1.423+11	1.239+03	1.712+00	2.400+00	3.348+10	3.348+10	5.801+05	2.588+05
94	3.384+10	5.833-01	1.436+11	1.248+03	1.714+00	2.400+00	3.384+10	3.384+10	5.822+05	2.601+05
95	3.420+10	5.825-01	1.449+11	1.258+03	1.717+00	2.400+00	3.420+10	3.420+10	5.842+05	2.615+05
96	3.456+10	5.817-01	1.462+11	1.268+03	1.719+00	2.400+00	3.456+10	3.456+10	5.863+05	2.629+05
97	3.492+10	5.809-01	1.474+11	1.277+03	1.722+00	2.400+00	3.492+10	3.492+10	5.883+05	2.643+05
98	3.528+10	5.809-01	1.482+11	1.288+03	1.722+00	2.400+00	3.528+10	3.528+10	5.899+05	2.650+05
99	3.564+10	5.793-01	1.499+11	1.297+03	1.726+00	2.400+00	3.564+10	3.564+10	5.923+05	2.669+05
100	3.600+10	5.785-01	1.512+11	1.306+03	1.729+00	2.400+00	3.600+10	3.600+10	5.944+05	2.683+05
101	3.636+10	5.785-01	1.520+11	1.317+03	1.729+00	2.400+00	3.636+10	3.636+10	5.959+05	2.690+05
102	3.672+10	5.770-01	1.537+11	1.326+03	1.733+00	2.400+00	3.672+10	3.672+10	5.983+05	2.709+05
103	3.708+10	5.770-01	1.545+11	1.337+03	1.733+00	2.400+00	3.708+10	3.708+10	5.998+05	2.716+05

TABLE B.5 (Continued)

100 Percent Water, 5 Percent Porosity Mixture (Continued)

104	3.744+10	5.755-01	1.562+11	1.345+03	1.738+00	2.400+00	3.744+10	3.744+10	6.022+05	2.736+05
105	3.780+10	5.755-01	1.570+11	1.356+03	1.738+00	2.400+00	3.780+10	3.780+10	6.037+05	2.743+05
106	3.816+10	5.740-01	1.587+11	1.364+03	1.742+00	2.400+00	3.816+10	3.816+10	6.061+05	2.762+05
107	3.852+10	5.740-01	1.595+11	1.375+03	1.742+00	2.400+00	3.852+10	3.852+10	6.076+05	2.769+05
108	3.888+10	5.725-01	1.613+11	1.384+03	1.747+00	2.400+00	3.888+10	3.888+10	6.099+05	2.788+05
109	3.924+10	5.725-01	1.620+11	1.395+03	1.747+00	2.400+00	3.924+10	3.924+10	6.114+05	2.795+05
110	3.960+10	5.710-01	1.637+11	1.403+03	1.751+00	2.400+00	3.960+10	3.960+10	6.137+05	2.814+05
111	3.996+10	5.710-01	1.645+11	1.414+03	1.751+00	2.400+00	3.996+10	3.996+10	6.152+05	2.820+05
112	4.032+10	5.696-01	1.662+11	1.422+03	1.756+00	2.400+00	4.032+10	4.032+10	6.174+05	2.839+05
113	4.068+10	5.696-01	1.670+11	1.433+03	1.756+00	2.400+00	4.068+10	4.068+10	6.189+05	2.846+05
114	4.104+10	5.682-01	1.687+11	1.441+03	1.760+00	2.400+00	4.104+10	4.104+10	6.212+05	2.864+05
115	4.140+10	5.682-01	1.695+11	1.452+03	1.760+00	2.400+00	4.140+10	4.140+10	6.226+05	2.871+05
116	4.176+10	5.669-01	1.712+11	1.461+03	1.764+00	2.400+00	4.176+10	4.176+10	6.248+05	2.889+05
117	4.212+10	5.669-01	1.720+11	1.472+03	1.764+00	2.400+00	4.212+10	4.212+10	6.263+05	2.896+05
118	4.248+10	5.655-01	1.737+11	1.480+03	1.768+00	2.400+00	4.248+10	4.248+10	6.284+05	2.914+05
119	4.284+10	5.655-01	1.745+11	1.491+03	1.768+00	2.400+00	4.284+10	4.284+10	6.299+05	2.921+05
120	4.320+10	5.642-01	1.761+11	1.499+03	1.772+00	2.400+00	4.320+10	4.320+10	6.320+05	2.939+05
121	4.356+10	5.642-01	1.769+11	1.510+03	1.772+00	2.400+00	4.356+10	4.356+10	6.335+05	2.945+05
122	4.392+10	5.629-01	1.786+11	1.518+03	1.777+00	2.400+00	4.392+10	4.392+10	6.356+05	2.963+05
123	4.428+10	5.629-01	1.794+11	1.529+03	1.777+00	2.400+00	4.428+10	4.428+10	6.370+05	2.970+05
124	4.464+10	5.616-01	1.811+11	1.538+03	1.781+00	2.400+00	4.464+10	4.464+10	6.391+05	2.987+05
125	4.500+10	5.616-01	1.818+11	1.549+03	1.781+00	2.400+00	4.500+10	4.500+10	6.405+05	2.994+05
126	4.536+10	5.603-01	1.835+11	1.557+03	1.785+00	2.400+00	4.536+10	4.536+10	6.426+05	3.011+05
127	4.572+10	5.603-01	1.843+11	1.568+03	1.785+00	2.400+00	4.572+10	4.572+10	6.440+05	3.018+05
128	4.608+10	5.591-01	1.860+11	1.576+03	1.789+00	2.400+00	4.608+10	4.608+10	6.461+05	3.035+05
129	4.644+10	5.591-01	1.867+11	1.587+03	1.789+00	2.400+00	4.644+10	4.644+10	6.479+05	3.042+05
130	4.680+10	5.579-01	1.884+11	1.595+03	1.793+00	2.400+00	4.680+10	4.680+10	6.495+05	3.059+05
131	4.716+10	5.579-01	1.892+11	1.607+03	1.793+00	2.400+00	4.716+10	4.716+10	6.508+05	3.065+05
132	4.752+10	5.567-01	1.908+11	1.615+03	1.786+00	2.400+00	4.752+10	4.752+10	6.529+05	3.082+05
133	4.788+10	5.567-01	1.916+11	1.626+03	1.796+00	2.400+00	4.788+10	4.788+10	6.542+05	3.089+05
134	4.824+10	5.555-01	1.933+11	1.634+03	1.800+00	2.400+00	4.824+10	4.824+10	6.562+05	3.106+05
135	4.860+10	5.555-01	1.940+11	1.645+03	1.800+00	2.400+00	4.860+10	4.860+10	6.575+05	3.112+05
136	4.896+10	5.543-01	1.957+11	1.653+03	1.804+00	2.400+00	4.896+10	4.896+10	6.595+05	3.129+05
137	4.932+10	5.543-01	1.965+11	1.664+03	1.804+00	2.400+00	4.932+10	4.932+10	6.609+05	3.135+05
138	4.968+10	5.531-01	1.981+11	1.673+03	1.808+00	2.400+00	4.968+10	4.968+10	6.628+05	3.152+05
139	5.004+10	5.531-01	1.989+11	1.684+03	1.808+00	2.400+00	5.004+10	5.004+10	6.642+05	3.158+05
140	5.040+10	5.520-01	2.005+11	1.692+03	1.812+00	2.400+00	5.040+10	5.040+10	6.661+05	3.174+05
141	5.076+10	5.520-01	2.013+11	1.703+03	1.812+00	2.400+00	5.076+10	5.076+10	6.679+05	3.181+05
142	5.112+10	5.509-01	2.029+11	1.711+03	1.815+00	2.400+00	5.112+10	5.112+10	6.694+05	3.197+05
143	5.148+10	5.509-01	2.037+11	1.722+03	1.815+00	2.400+00	5.148+10	5.148+10	6.706+05	3.203+05
144	5.184+10	5.497-01	2.053+11	1.730+03	1.819+00	2.400+00	5.184+10	5.184+10	6.726+05	3.219+05
145	5.220+10	5.497-01	2.061+11	1.741+03	1.819+00	2.400+00	5.220+10	5.220+10	6.738+05	3.226+05
146	5.256+10	5.487-01	2.077+11	1.750+03	1.823+00	2.400+00	5.256+10	5.256+10	6.758+05	3.242+05
147	5.292+10	5.487-01	2.085+11	1.761+03	1.823+00	2.400+00	5.292+10	5.292+10	6.770+05	3.248+05
148	5.328+10	5.476-01	2.101+11	1.769+03	1.826+00	2.400+00	5.328+10	5.328+10	6.789+05	3.264+05
149	5.364+10	5.476-01	2.109+11	1.780+03	1.826+00	2.400+00	5.364+10	5.364+10	6.802+05	3.270+05
150	5.400+10	5.465-01	2.125+11	1.788+03	1.830+00	2.400+00	5.400+10	5.400+10	6.820+05	3.286+05
151	5.436+10	5.465-01	2.133+11	1.799+03	1.830+00	2.400+00	5.436+10	5.436+10	6.833+05	3.292+05
152	5.472+10	5.454-01	2.149+11	1.807+03	1.833+00	2.400+00	5.472+10	5.472+10	6.852+05	3.308+05
153	5.508+10	5.454-01	2.157+11	1.818+03	1.833+00	2.400+00	5.508+10	5.508+10	6.864+05	3.314+05
154	5.544+10	5.444-01	2.173+11	1.826+03	1.837+00	2.400+00	5.544+10	5.544+10	6.882+05	3.329+05
155	5.580+10	5.444-01	2.181+11	1.838+03	1.837+00	2.400+00	5.580+10	5.580+10	6.895+05	3.335+05
156	5.616+10	5.434-01	2.197+11	1.846+03	1.840+00	2.400+00	5.616+10	5.616+10	6.913+05	3.351+05
157	5.652+10	5.434-01	2.204+11	1.857+03	1.840+00	2.400+00	5.652+10	5.652+10	6.925+05	3.357+05

TABLE B.5 (Continued)

100 Percent Water, 5 Percent Porosity Mixture (Continued)

158	5.688+10	5.429-01	2.220+11	1.865+03	1.844+00	2.400+00	5.688+10	5.688+10	6.943+05	3.372+05
159	5.724+10	5.429-01	2.228+11	1.876+03	1.844+00	2.400+00	5.724+10	5.724+10	6.956+05	3.378+05
160	5.760+10	5.419-01	2.244+11	1.884+03	1.847+00	2.400+00	5.760+10	5.760+10	6.974+05	3.394+05
161	5.796+10	5.419-01	2.252+11	1.895+03	1.847+00	2.400+00	5.796+10	5.796+10	6.986+05	3.399+05
162	5.832+10	5.409-01	2.268+11	1.903+03	1.851+00	2.400+00	5.832+10	5.832+10	7.003+05	3.415+05
163	5.868+10	5.409-01	2.276+11	1.914+03	1.851+00	2.400+00	5.868+10	5.868+10	7.015+05	3.421+05
164	5.904+10	5.399-01	2.291+11	1.923+03	1.854+00	2.400+00	5.904+10	5.904+10	7.033+05	3.436+05
165	5.940+10	5.399-01	2.299+11	1.934+03	1.854+00	2.400+00	5.940+10	5.940+10	7.045+05	3.442+05
166	5.976+10	5.384-01	2.315+11	1.942+03	1.857+00	2.400+00	5.976+10	5.976+10	7.063+05	3.457+05
167	6.012+10	5.384-01	2.323+11	1.953+03	1.857+00	2.400+00	6.012+10	6.012+10	7.074+05	3.462+05
168	6.048+10	5.375-01	2.339+11	1.961+03	1.861+00	2.400+00	6.048+10	6.048+10	7.092+05	3.477+05
169	6.084+10	5.375-01	2.346+11	1.972+03	1.861+00	2.400+00	6.084+10	6.084+10	7.104+05	3.483+05
170	6.120+10	5.365-01	2.362+11	1.980+03	1.864+00	2.400+00	6.120+10	6.120+10	7.121+05	3.498+05
171	6.156+10	5.365-01	2.370+11	1.991+03	1.864+00	2.400+00	6.156+10	6.156+10	7.133+05	3.504+05
172	6.192+10	5.356-01	2.386+11	2.000+03	1.867+00	2.400+00	6.192+10	6.192+10	7.150+05	3.519+05
173	6.228+10	5.356-01	2.393+11	2.011+03	1.867+00	2.400+00	6.228+10	6.228+10	7.161+05	3.524+05
174	6.264+10	5.346-01	2.409+11	2.019+03	1.870+00	2.400+00	6.264+10	6.264+10	7.178+05	3.539+05
175	6.300+10	5.346-01	2.417+11	2.030+03	1.870+00	2.400+00	6.300+10	6.300+10	7.190+05	3.545+05
176	6.336+10	5.337-01	2.432+11	2.038+03	1.874+00	2.400+00	6.336+10	6.336+10	7.207+05	3.559+05
177	6.372+10	5.337-01	2.440+11	2.049+03	1.874+00	2.400+00	6.372+10	6.372+10	7.218+05	3.565+05
178	6.408+10	5.328-01	2.456+11	2.057+03	1.877+00	2.400+00	6.408+10	6.408+10	7.235+05	3.579+05
179	6.444+10	5.328-01	2.464+11	2.068+03	1.877+00	2.400+00	6.444+10	6.444+10	7.246+05	3.585+05
180	6.480+10	5.319-01	2.479+11	2.077+03	1.880+00	2.400+00	6.480+10	6.480+10	7.263+05	3.600+05
181	6.516+10	5.319-01	2.487+11	2.088+03	1.880+00	2.400+00	6.516+10	6.516+10	7.274+05	3.605+05
182	6.552+10	5.310-01	2.503+11	2.096+03	1.883+00	2.400+00	6.552+10	6.552+10	7.291+05	3.619+05
183	6.588+10	5.310-01	2.510+11	2.107+03	1.883+00	2.400+00	6.588+10	6.588+10	7.302+05	3.625+05
184	6.624+10	5.302-01	2.526+11	2.115+03	1.886+00	2.400+00	6.624+10	6.624+10	7.319+05	3.639+05
185	6.660+10	5.302-01	2.533+11	2.126+03	1.886+00	2.400+00	6.660+10	6.660+10	7.330+05	3.645+05
186	6.696+10	5.293-01	2.549+11	2.134+03	1.889+00	2.400+00	6.696+10	6.696+10	7.346+05	3.659+05
187	6.732+10	5.293-01	2.557+11	2.145+03	1.889+00	2.400+00	6.732+10	6.732+10	7.357+05	3.665+05
188	6.768+10	5.293-01	2.564+11	2.156+03	1.889+00	2.400+00	6.768+10	6.768+10	7.368+05	3.670+05
189	6.804+10	5.281-01	2.583+11	2.163+03	1.894+00	2.400+00	6.804+10	6.804+10	7.387+05	3.688+05
190	6.840+10	5.281-01	2.591+11	2.174+03	1.894+00	2.400+00	6.840+10	6.840+10	7.398+05	3.693+05
191	6.876+10	5.272-01	2.607+11	2.182+03	1.897+00	2.400+00	6.876+10	6.876+10	7.414+05	3.708+05
192	6.912+10	5.272-01	2.615+11	2.193+03	1.897+00	2.400+00	6.912+10	6.912+10	7.425+05	3.713+05
193	6.948+10	5.272-01	2.622+11	2.204+03	1.897+00	2.400+00	6.948+10	6.948+10	7.436+05	3.719+05
194	6.984+10	5.260-01	2.641+11	2.211+03	1.901+00	2.400+00	6.984+10	6.984+10	7.459+05	3.736+05
195	7.020+10	5.260-01	2.649+11	2.222+03	1.901+00	2.400+00	7.020+10	7.020+10	7.465+05	3.742+05
196	7.056+10	5.251-01	2.665+11	2.230+03	1.904+00	2.400+00	7.056+10	7.056+10	7.481+05	3.756+05
197	7.092+10	5.251-01	2.672+11	2.241+03	1.904+00	2.400+00	7.092+10	7.092+10	7.492+05	3.761+05
198	7.128+10	5.251-01	2.680+11	2.252+03	1.904+00	2.400+00	7.128+10	7.128+10	7.503+05	3.767+05
199	7.164+10	5.239-01	2.699+11	2.259+03	1.909+00	2.400+00	7.164+10	7.164+10	7.521+05	3.784+05
200	7.200+10	5.239-01	2.706+11	2.270+03	1.909+00	2.400+00	7.200+10	7.200+10	7.531+05	3.789+05
201	7.236+10	5.239-01	2.714+11	2.281+03	1.909+00	2.400+00	7.236+10	7.236+10	7.542+05	3.795+05
202	7.272+10	5.227-01	2.733+11	2.288+03	1.913+00	2.400+00	7.272+10	7.272+10	7.560+05	3.812+05
203	7.308+10	5.227-01	2.741+11	2.299+03	1.913+00	2.400+00	7.308+10	7.308+10	7.570+05	3.818+05
204	7.344+10	5.227-01	2.748+11	2.310+03	1.913+00	2.400+00	7.344+10	7.344+10	7.581+05	3.823+05
205	7.380+10	5.215-01	2.768+11	2.317+03	1.917+00	2.400+00	7.380+10	7.380+10	7.599+05	3.841+05
206	7.416+10	5.215-01	2.775+11	2.328+03	1.917+00	2.400+00	7.416+10	7.416+10	7.609+05	3.846+05
207	7.452+10	5.215-01	2.783+11	2.339+03	1.917+00	2.400+00	7.452+10	7.452+10	7.620+05	3.851+05
208	7.488+10	5.204-01	2.802+11	2.346+03	1.922+00	2.400+00	7.488+10	7.488+10	7.637+05	3.869+05
209	7.524+10	5.204-01	2.809+11	2.357+03	1.922+00	2.400+00	7.524+10	7.524+10	7.648+05	3.874+05
210	7.560+10	5.204-01	2.817+11	2.368+03	1.922+00	2.400+00	7.560+10	7.560+10	7.658+05	3.879+05
211	7.596+10	5.192-01	2.836+11	2.375+03	1.926+00	2.400+00	7.596+10	7.596+10	7.676+05	3.897+05

TABLE B.5 (Continued)

100 Percent Water, 5 Percent Porosity Mixture (Continued)

212	7.632+10	5.192-01	2.844+11	2.386+03	1.926+00	2.400+00	7.632+10	7.632+10	7.684+05	3.902+05
213	7.668+10	5.192-01	2.851+11	2.397+03	1.926+00	2.400+00	7.668+10	7.668+10	7.694+05	3.907+05
214	7.704+10	5.181-01	2.870+11	2.409+03	1.930+00	2.400+00	7.704+10	7.704+10	7.714+05	3.924+05
215	7.740+10	5.181-01	2.878+11	2.415+03	1.930+00	2.400+00	7.740+10	7.740+10	7.724+05	3.929+05
216	7.776+10	5.181-01	2.886+11	2.426+03	1.930+00	2.400+00	7.776+10	7.776+10	7.734+05	3.934+05
217	7.812+10	5.169-01	2.905+11	2.432+03	1.934+00	2.400+00	7.812+10	7.812+10	7.751+05	3.952+05
218	7.848+10	5.169-01	2.912+11	2.443+03	1.934+00	2.400+00	7.848+10	7.848+10	7.761+05	3.957+05
219	7.884+10	5.169-01	2.920+11	2.454+03	1.934+00	2.400+00	7.884+10	7.884+10	7.771+05	3.962+05
220	7.920+10	5.158-01	2.939+11	2.461+03	1.939+00	2.400+00	7.920+10	7.920+10	7.789+05	3.979+05
221	7.956+10	5.158-01	2.946+11	2.472+03	1.939+00	2.400+00	7.956+10	7.956+10	7.799+05	3.984+05
222	7.992+10	5.158-01	2.954+11	2.483+03	1.939+00	2.400+00	7.992+10	7.992+10	7.809+05	3.989+05
223	8.028+10	5.147-01	2.973+11	2.490+03	1.943+00	2.400+00	8.028+10	8.028+10	7.826+05	4.006+05
224	8.064+10	5.147-01	2.980+11	2.501+03	1.943+00	2.400+00	8.064+10	8.064+10	7.836+05	4.011+05
225	8.100+10	5.147-01	2.988+11	2.512+03	1.943+00	2.400+00	8.100+10	8.100+10	7.846+05	4.016+05
226	8.136+10	5.137-01	3.007+11	2.519+03	1.947+00	2.400+00	8.136+10	8.136+10	7.863+05	4.033+05

APPENDIX C
SKIPPER NUMERICAL EXPERIMENTS SUPPLEMENT

SKIPPER CODE

The SKIPPER code is a modified version of the RIP code, developed at S^3 under the DASA-sponsored PREDIX study.[58] All radiation subroutines have been removed from the original RIP. In the initial version of SKIPPER (described in 3SR-267), a special routine was encoded to permit the treatment of a pulse propagating through an extended laminate structure. As many as 25 bilaminates (between two end-blocks) can be studied in a given run.

During the past year, a number of additional features have been added to the code. The equations of state for $\overline{\text{NTS}}$ poreless tuff and water given in Appendix B have been incorporated. The P(V,E) form is employed to compute the hydrodynamics of the materials and is required for a (newly included) step-by-step updating of pressure. Important complimentary information for each zone is obtained by utilizing the thermal equations of state, E = E(V,T) to calculate the temperature and entropy.

The expression for entropy is derived as follows:

$$dS = \frac{dE}{T} + \frac{PdV}{T} \tag{C.1}$$

For the present equations of state, C_V is constant for each material. The thermal form,

$$E - E_0 = C_V\left(T - T_0\right) - \int_{V_0}^{V} h_1 (V) dV , \tag{C.2}$$

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where $h_1(V)$ is the zero degree isotherm (3SR-267), may be differentiated to give

$$dE = C_V dT - h_1'(V)dV \tag{C.3}$$

Since $P(V,E)$ has an alternative form, i.e.,

$$P(V,E) = P(V,T) = h_1(V) + Th_2(V) \ , \tag{C.4}$$

the equation for entropy may be written

$$dS = \frac{C_V dT}{T} + h_2 dV \ . \tag{C.5}$$

Thus, the entropy is given by

$$S - S_0 = C_V \left\{ \ell n \frac{T}{T_0} + \int_{V_0}^{V} \frac{G\ (V)}{V}\, dV \right\} \tag{C.6}$$

where

$$h_2(V) = \frac{C_V G\ (V)}{V}$$

<u>SKIPPER SERIES</u>

A total of eight SKIPPER runs were conducted in the series described in Section 3.3 and 3.5. All but one of these has been reported in Chapter III. A summary of these runs is provided in Table C.1. The characteristic frequency of mechanical oscillations in the laminates, ω^*, the real time duration of each case, and the sequence of laminates utilized in Run 775 to simulate the randomness of geologic materials are included in Table C.1.

TABLE C.1

Run Summary--SKIPPER Bilaminate Calculations

Run	Left Boundary Velocity $\times 10^5$ cm/sec	(1) x cm	(2) x cm	(3) x cm	M_w	U	ω^* mHz	Real Time duration (μsec)	Comments
770	.7786	.0703	.0297	0.00	.15	3.70±.05	2.1±.05	8.6	Orderly structure TWTW...
775	.7786	.0703	.0297	0	.15	3.70±.05	-	8.4	Random structure zoning: 5 water, 14 tuff WTTWWTWTTWWTTWTWWTTWTTWWTW TWWTTWTTWWTWTWWTTWTWTTWWT
780	.7786	.0703	.0297	0	.15	3.70±.05	2.1±.1	3.6	Orderly--Double zoning 10 water, 28 tuff.
785	1.25	.0703	.0297	0	.15	4.41±.05	2.5±.0	4.4	Orderly--Double zoning
790*	.15	.0703	.0297	0	.15	2.37±.05	1.2±.1	6.4	Low velocity run--Entropy, temperature improperly edited $\bar{P} \sim 7$ kbar (P*EQ prediction for $S_w = 0$; P = 6.94 kbar)
795	.7786	.0703	.0148	.0148	.081	2.90±.1	1.86±.05	6.7	Void gaps employed to simulate porosity. Orderly structure: TWVTWV....
800	1.25	.0057	.0443		.25	4.35±.10	2.5±.0	4.5	
805	2.2	.0557	.0443		.25	5.64±.15	3.33±.1	4.3	

The run not presented in Chapter III is 790. This was a low-particle velocity run wherein the temperature-entropy edit subroutine contained an error that made the results difficult to interpret on a thermodynamic basis. However, the mechanical terms were correctly computed and the run yielded some illuminating results discussed in a later section of this appendix. Spot hand calculations of the entropy indicate that the water experienced almost no entropy gain (the P*EQ pressure for $S_W = 0$ is given in Table C.1).

ZONE SIZE EFFECTS

Run 780 was a duplicate of 770, except that the number of zones in each laminate was doubled. No major differences in the results were observed. A particularly sensitive measure of the degree of coincidence is afforded by a comparison of the entropy in the laminates at comparable (real) times. Table C.2 gives evidence that the double-zoning case is very nearly identical to run 770.

SHOCK WAVE PROPAGATION VELOCITY

Listed in Table C.1 are the average values of the velocity at which the initial disturbance propagates into the laminate structure. These values were obtained from observations of the times at which the entropy of the individual laminates was increased above 10^3 ergs/cm-deg K by the wave. The spread in the velocity is comparable to the error in "reading" the shock arrival time. There was no trend in the data which indicated that the wave was accelerating. As pointed out in the text, the discrepancy between the shock pressures in Table 3.2 are attributed to the non-steady nature of the wave propagation in the laminated structure. That is, in the time allotted, a true

TABLE C.2

Average Entropy in Water Laminates* at $t \approx 3.6$ μsec. Entropy × 10^6 ergs/gm-deg K

Water Laminate	Run 770	Run 780
1	5.12	5.17
2	4.15	4.11
3	4.05	4.01
4	4.28	4.07
5	4.60	4.34
6	4.80	4.85
7	4.80	4.71
8	4.60	4.51
9	4.45	4.35

*Apparently, slightly higher entropy production is achieved with the coarser zoning utilized in 770. The difference is, at most, only 3 percent. This corresponds to no change in the pressure for three significant numbers and about a 3 percent change in the temperature.

steady wave has not yet formed; the interaction regime is still growing. It is apparent, however, that the overall wave (train) velocity has stabilized. The disturbance is classified as quasi-steady in the sense that it is propagating at a constant velocity while the shock zone is spreading.

CHARACTERISTIC FREQUENCY OF MECHANICAL OSCILLATIONS

As might be anticipated, the "orderly" sequence of bilaminates imposes a certain periodicity on the wave interaction phenomena. It was observed that after only two to three oscillations following initial disturbance, a characteristic frequency of these oscillations, ω^*, dominated the mechanical motion.

In non-linear materials such as $\overline{\text{NTS}}$ tuff and water, the speed of propagation of disturbances varies with the level of excitation. It is not possible at present to define a "resonant" frequency for the system. However a resonance at each stress level does exist. Table C.2 lists the observed frequencies of oscillation for the various runs. From these values, it is clear that, for the same geometric structure $n_0^{(1)} = .703$, $n_0^{(2)} = .297$, $n_0^{(3)} = 0$), a higher imposed velocity results in (almost) proportional increases in ω_*. It is of interest to note that runs 785 and 800, which have somewhat different geometries but the same loading velocity, have the same observed frequency of oscillation.

OSCILLATORY MODES

For small excitations, the "orderly" structures utilized in runs 770, 780-790, yield one normal mode of oscillation: The tuff plates act as rigid masses, connected by the more compressible water layers. This is similar to the problem of a 1-D lattice of springs and masses, as

treated in standard works[59,60].

Oscillations of this type can be observed very clearly in run 790, where a low loading velocity was imposed onto the standard periodic structure. In Fig. C.1 and C.2, the spatially-averaged particle velocities and pressures in layers 8 (a poreless $\overline{\mathrm{NTS}}$ tuff plate) and 9 (a water layer) of the periodic structure are exhibited. These two layers are quite representative of the other tuff and water layers. It is clear from Fig. C.1a that tuff plates are first accelerated up to the neighborhood of the loading velocity, and thereafter describe a form of damped oscillatory motion about that velocity. Figure C.2 shows that water layers are accelerated up to the imposed speed, but then just have small, irregular motions about that level. Figures C.2a and C.2b are space-averaged pressures, and show that while both tuff and water receive an initial shock up to approximately the equilibrium level, only the water is subjected to significant secondary compressions and rarefactions. Table C.3 illustrates the situation for the first seven tuff plates. In this table are shown some of the times of the maxima and minima of spacially-averaged particle velocity in these tuff layers. From this, it can be seen that the tuff plates are engaged in longitudinal oscillations about the equilibrium speed; when the nth tuff layer is moving forward faster than V_0, then the $(n \pm 1)$th tuff layer is moving forward slower than V_0.

Similar plots for runs 780 and 785 show that, with increased levels of excitation, the system's oscillatory energy shifts partially into another mode. With the higher levels of loading velocity, the water layers begin more regular motion in their own right. This mode is also somewhat like a system of masses and springs, but one in which the water attempts to act as masses, connected by springs (the tuff). The oscillations in this mode appear combined

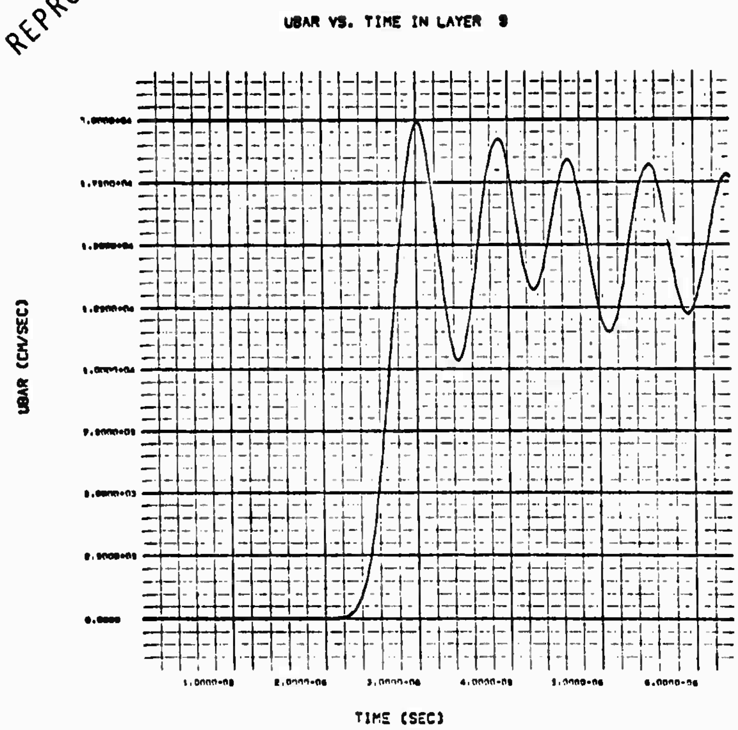

Fig. C.1a--Average particle velocity, UBAR, in the 4th NTS tuff laminate - Run 790.

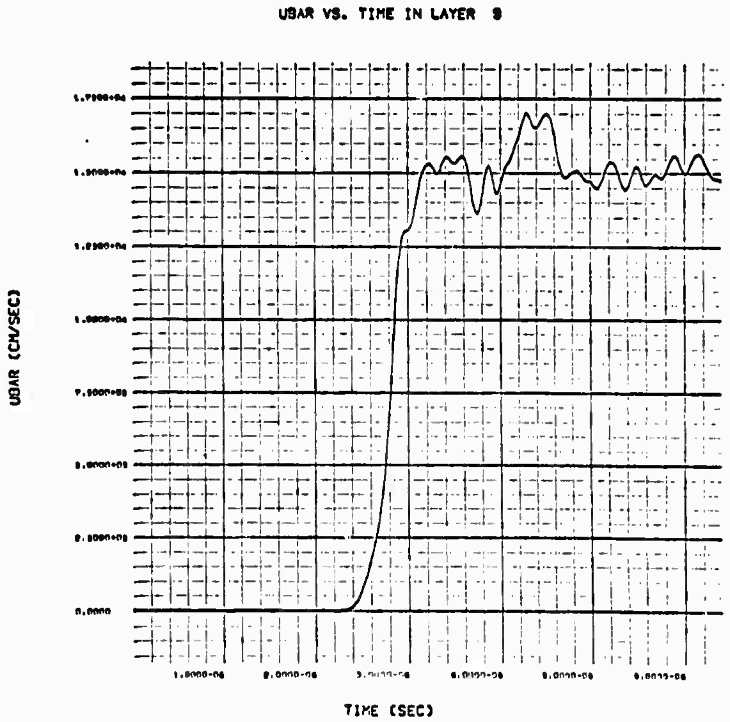

Fig. C.1b--Average particle velocity, UBAR, in the 4th water laminate - Run 790.

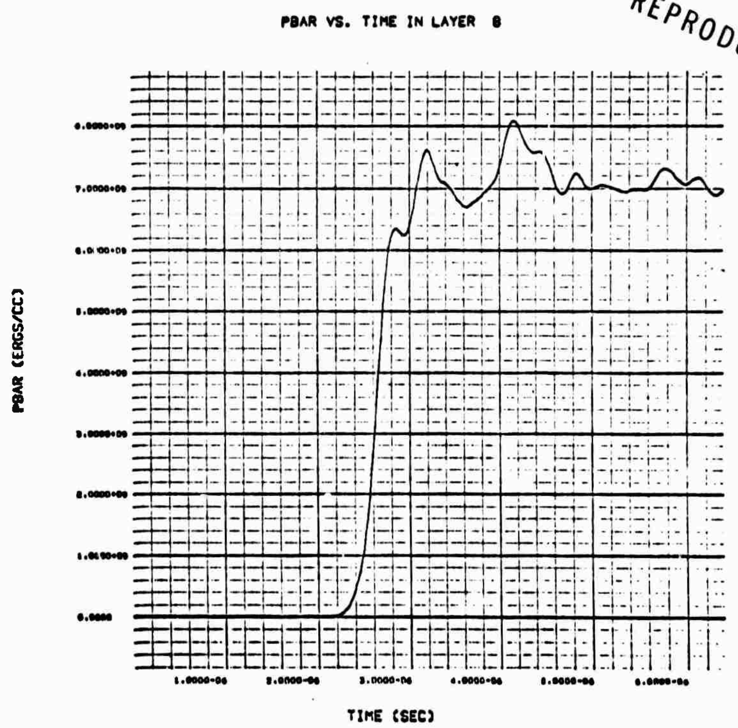

Fig. C.2a--Average pressure, PBAR, in the 4th NTS tuff laminate - Run 790.

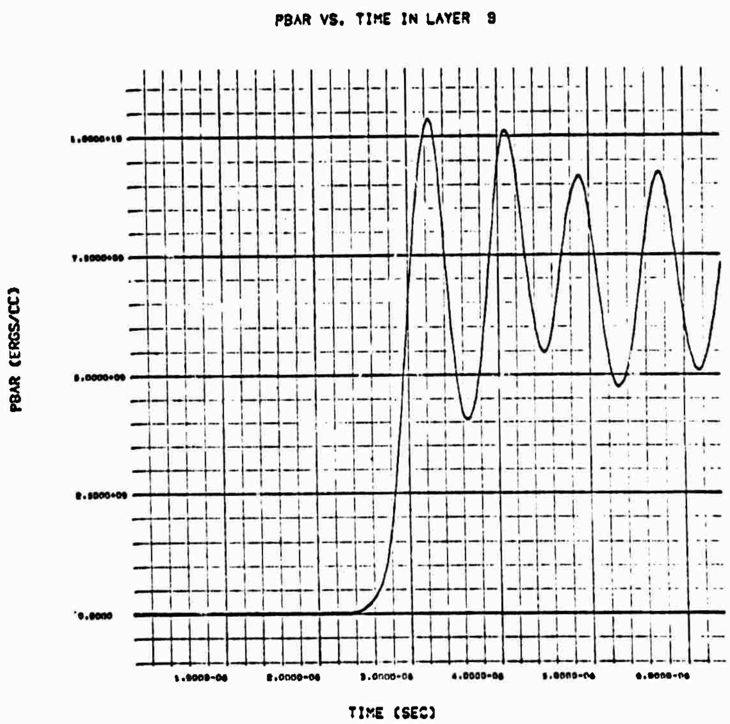

Fig. C.2b--Average pressure, PBAR, in the 4th water laminate - Run 790.

TABLE C.3

Times of Velocity Extrema in Tuff Layers of Run 790

Layer 2	Layer 4	Layer 6	Layer 8	Layer 10	Layer 12	Layer 14
1.67X						
2.05N	2.13X					
2.50X	2.60N	2.58X				
2.92N	3.01X	3.02N	3.02X			
3.37X	3.38N	3.46X	3.43N	3.43X		
3.82N	3.78X	3.82N	3.90X	3.87N	3.87X	
4.20X	4.23N	4.22X	4.27N	4.32X	4.29N	4.28X
4.61N	4.67X	4.67N	4.66X	4.63N	4.74X	4.72N
5.04X	5.08N	5.12X	5.11N	5.10X	5.15N	5.15X
5.52N	5.50X	5.51N	5.53X	5.53N	5.53X	5.58N
5.93X	5.93N	5.92X	5.93N	5.95X	5.94N	5.95X
6.33N	6.33X	6.33N	6.33X	6.38N	6.40X	6.41N

All times are in μsec; X denotes a maximum, and N a minimum. Layer 2n is the nth poreless tuff plate. Thus the layers above are poreless tuff layers 1 - 7.

with the first-mode activity in both runs 780 and 785. Figures C.3 and C.4 display, for run 785, the same quantities in the same laminates as do Figs. C.1 and C.2. From these plots, it is clear that the water layers are behaving more like moving objects than they were at the lower excitation level, in addition to their role as "springs" for the moving tuff plates.

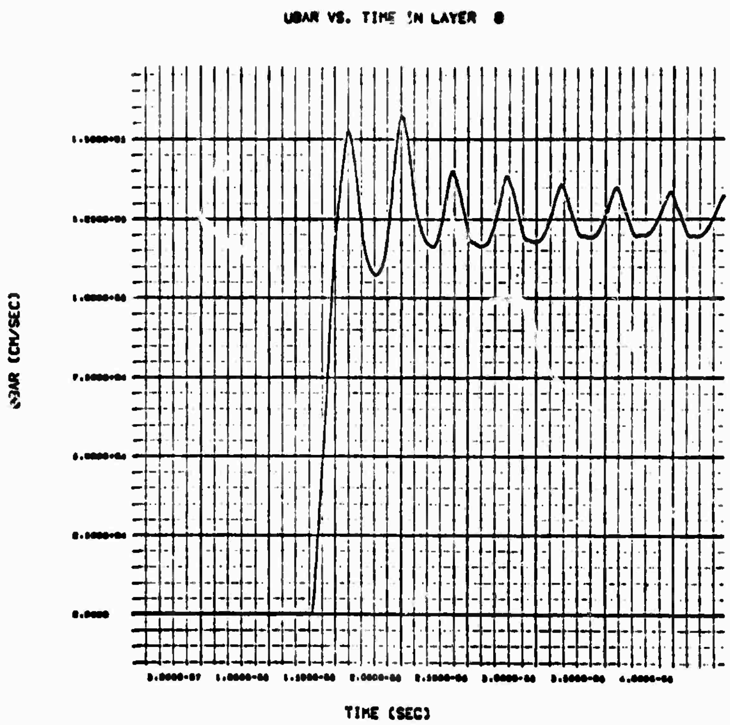

Fig. C.3a--Average particle velocity, UBAR, in the 4th NTS tuff laminate - Run 785.

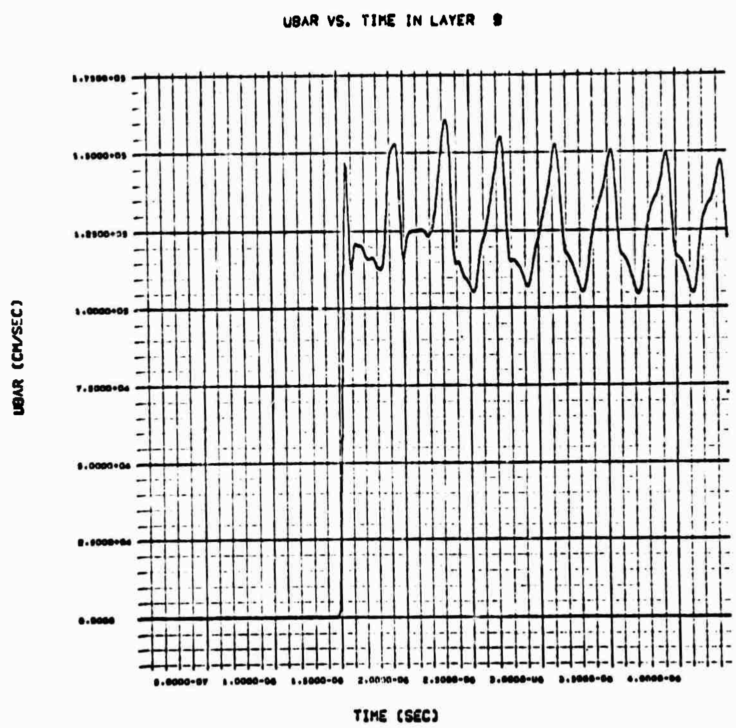

Fig. C.3b--Average particle velocity, UBAR, in the 4th water laminate - Run 785.

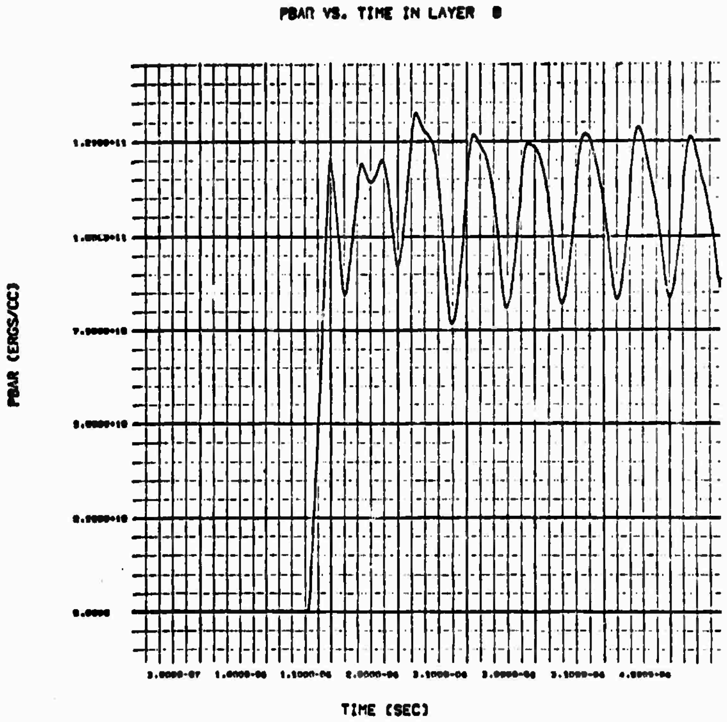

Fig. C.4a--Average pressure, PBAR, in the 4th NTS tuff laminate - Run 785.

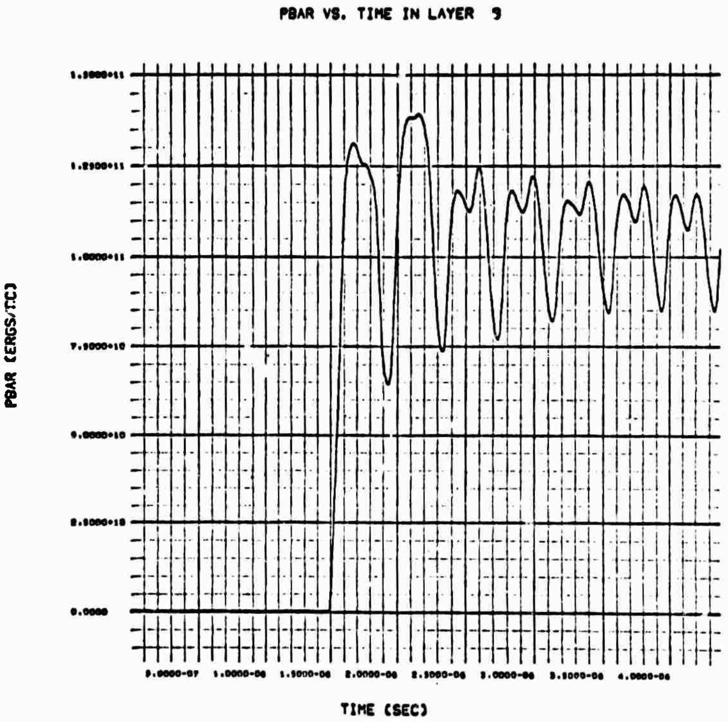

Fig. C.4b--Average pressure, PBAR, in the 4th water laminate - Run 785.

APPENDIX D
POROUS FINITE DIFFERENCE SCHEME

Provisional Values at $(j+\frac{1}{2},\ n+\frac{1}{2})$:

$$\lambda_{j+\frac12}^{n+\frac12} = \frac{1}{2}\left(\lambda_{j+1}^{n} + \lambda_{j}^{n}\right) + \frac{\Delta\tau}{2\Delta Z}\left(\bar{v}_{j+1}^{n} - \bar{v}_{j}^{n}\right),$$

$$\gamma_{j+\frac12}^{n+\frac12} = \frac{1}{2}\left(\gamma_{j+1}^{n} + \gamma_{j}^{n}\right) - \frac{\Delta\tau}{2\Delta Z}\left(\frac{\bar{w}_{j+1}^{n} - \bar{v}_{j+1}^{n} + \bar{w}_{j}^{n} - \bar{v}_{j}^{n}}{\lambda_{j+1}^{n} + \lambda_{j}^{n}}\right)$$

$$\cdot\left(\gamma_{j+1}^{n} - \gamma_{j}^{n}\right) + \frac{\Delta\tau}{2\Delta Z}\,\frac{\gamma_{j+1}^{n} + \gamma_{j}^{n}}{\lambda_{j+1}^{n} + \lambda_{j}^{n}}\left(\bar{w}_{j+1}^{n} - \bar{w}_{j}^{n}\right),$$

$$\bar{v}_{j+\frac12}^{n+\frac12} = \frac{1}{2}\left(\bar{v}_{j+1}^{n} + \bar{v}_{j}^{n}\right) + \frac{\Delta\tau}{2}\,\frac{\bar{d}}{c_{0}}\,\frac{1}{4}\left(\lambda_{j+1}^{n} + \lambda_{j}^{n}\right)$$

$$\cdot\left(\bar{w}_{j+1}^{n} + \bar{w}_{j}^{n} - \bar{v}_{j+1}^{n} - \bar{v}_{j}^{n}\right) + \frac{\Delta\tau}{2\Delta Z}\left\{\left(\overset{(1)}{\sigma}{}_{j+1}^{n} - \overset{(1)}{\sigma}{}_{j}^{n}\right),\right.$$

$$\left. + \frac{\overset{(2)}{\sigma}{}_{j+1}^{n} + \overset{(2)}{\sigma}{}_{j}^{n}}{\overset{(2)}{n}{}_{j+1}^{n} + \overset{(2)}{n}{}_{j}^{n}} \cdot \left(\overset{(2)}{n}{}_{j+1}^{n} - \overset{(2)}{n}{}_{j}^{n}\right)\right\}$$

$$\bar{w}_{j+\frac12}^{n+\frac12} = \frac{1}{2}\left(\bar{w}_{j+1}^{n} + \bar{w}_{j}^{n}\right) - \frac{\Delta\tau}{2\Delta Z}\,\frac{\bar{w}_{j+1}^{n} + \bar{w}_{j}^{n} - \bar{v}_{j+1}^{n} - \bar{v}_{j}^{n}}{\lambda_{j+1}^{n} + \lambda_{j}^{n}}$$

$$\cdot\left(\bar{w}_{j+1}^{n} - \bar{w}_{j}^{n}\right) - \frac{\bar{d}}{1-c_{0}}\,\frac{\Delta\tau}{8}\left(\gamma_{j+1}^{n} + \gamma_{j}^{n}\right)\left(\bar{w}_{j+1}^{n} + \bar{w}_{j}^{n} - \bar{v}_{j+1}^{n} - \bar{v}_{j}^{n}\right)$$

$$+ \frac{c_{0}}{1-c_{0}}\,\frac{\Delta\tau}{2\Delta Z}\,\frac{\gamma_{j+1}^{n} + \gamma_{j}^{n}}{\lambda_{j+1}^{n} + \lambda_{j}^{n}}\left\{\left(\overset{(2)}{\sigma}{}_{j+1}^{n} - \overset{(2)}{\sigma}{}_{j}^{n}\right)\right.$$

$$\left. - \frac{\overset{(2)}{\sigma}{}_{j+1}^{n} + \overset{(2)}{\sigma}{}_{j}^{n}}{\overset{(2)}{n}{}_{j+1}^{n} \quad \overset{(2)}{n}{}_{j}^{n}} \cdot \left(\overset{(2)}{n}{}_{j+1}^{n} + \overset{(2)}{n}{}_{j}^{n}\right)\right\}$$

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Final Values at (j, n+1):

$$\lambda_j^{n+1} = \lambda_j^n + \frac{\Delta\tau}{\Delta Z}\left(\bar{v}^{n+\frac{1}{2}}_{j+\frac{1}{2}} - \bar{v}^{n+\frac{1}{2}}_{j-\frac{1}{2}}\right),$$

$$\gamma_j^{n+1} = \gamma_j^n - \frac{\Delta\tau}{\Delta Z}\,\frac{\bar{w}^{n+\frac{1}{2}}_{j+\frac{1}{2}} + \bar{w}^{n+\frac{1}{2}}_{j-\frac{1}{2}} - \bar{v}^{n+\frac{1}{2}}_{j+\frac{1}{2}} - \bar{v}^{n+\frac{1}{2}}_{j-\frac{1}{2}}}{\lambda^{n+\frac{1}{2}}_{j+\frac{1}{2}} + \lambda^{n+\frac{1}{2}}_{j-\frac{1}{2}}}$$

$$\cdot\left(\gamma^{n+\frac{1}{2}}_{j+\frac{1}{2}} - \gamma^{n+\frac{1}{2}}_{j-\frac{1}{2}}\right) + \frac{\Delta\tau}{\Delta Z}\,\frac{\gamma^{n+\frac{1}{2}}_{j+\frac{1}{2}} + \gamma^{n+\frac{1}{2}}_{j-\frac{1}{2}}}{\lambda^{n+\frac{1}{2}}_{j+\frac{1}{2}} + \lambda^{n+\frac{1}{2}}_{j-\frac{1}{2}}}\left(\bar{w}^{n+\frac{1}{2}}_{j+\frac{1}{2}} - \bar{w}^{n+\frac{1}{2}}_{j-\frac{1}{2}}\right),$$

$$\bar{v}_j^{n+1} = \bar{v}_j^n + \Delta\tau\,\frac{\bar{d}}{c_0}\,\frac{1}{4}\left(\lambda^{n+\frac{1}{2}}_{j+\frac{1}{2}} + \lambda^{n+\frac{1}{2}}_{j-\frac{1}{2}}\right)\left(\bar{w}^{n+\frac{1}{2}}_{j+\frac{1}{2}} + \bar{w}^{n+\frac{1}{2}}_{j-\frac{1}{2}} - \bar{v}^{n+\frac{1}{2}}_{j+\frac{1}{2}} - \bar{v}^{n+\frac{1}{2}}_{j-\frac{1}{2}}\right)$$

$$+ \frac{\Delta\tau}{\Delta Z}\left\{\left(\overset{(1)}{\sigma}{}^{n+\frac{1}{2}}_{j+\frac{1}{2}} - \overset{(1)}{\sigma}{}^{n+\frac{1}{2}}_{j-\frac{1}{2}}\right) + \frac{\overset{(2)}{\sigma}{}^{n+\frac{1}{2}}_{j+\frac{1}{2}} + \overset{(2)}{\sigma}{}^{n+\frac{1}{2}}_{j-\frac{1}{2}}}{\overset{(2)}{n}{}^{n+\frac{1}{2}}_{j+\frac{1}{2}} + \overset{(2)}{n}{}^{n+\frac{1}{2}}_{j-\frac{1}{2}}}\left(\overset{(2)}{n}{}^{n+\frac{1}{2}}_{j+\frac{1}{2}} - \overset{(2)}{n}{}^{n+\frac{1}{2}}_{j-\frac{1}{2}}\right)\right\}$$

$$\bar{w}_j^{n+1} = \bar{w}_j^n - \frac{\Delta\tau}{\Delta Z}\,\frac{\bar{w}^{n+\frac{1}{2}}_{j+\frac{1}{2}} + \bar{w}^{n+\frac{1}{2}}_{j-\frac{1}{2}} - \bar{v}^{n+\frac{1}{2}}_{j+\frac{1}{2}} - \bar{v}^{n+\frac{1}{2}}_{j-\frac{1}{2}}}{\lambda^{n+\frac{1}{2}}_{j+\frac{1}{2}} + \lambda^{n+\frac{1}{2}}_{j-\frac{1}{2}}}$$

$$\cdot\left(\bar{w}^{n+\frac{1}{2}}_{j+\frac{1}{2}} - \bar{w}^{n+\frac{1}{2}}_{j-\frac{1}{2}}\right) - \frac{\bar{d}}{1-c_0}\,\frac{\Delta\tau}{4}\left(\gamma^{n+\frac{1}{2}}_{j+\frac{1}{2}} + \gamma^{n+\frac{1}{2}}_{j-\frac{1}{2}}\right)$$

$$\cdot\left(\bar{w}^{n+\frac{1}{2}}_{j+\frac{1}{2}} + \bar{w}^{n+\frac{1}{2}}_{j-\frac{1}{2}} - \bar{v}^{n+\frac{1}{2}}_{j+\frac{1}{2}} - \bar{v}^{n+\frac{1}{2}}_{j-\frac{1}{2}}\right) + \frac{c_0}{1-c_0}\,\frac{\Delta\tau}{\Delta Z}\cdot\frac{\gamma^{n+\frac{1}{2}}_{j+\frac{1}{2}} + \gamma^{n+\frac{1}{2}}_{j-\frac{1}{2}}}{\lambda^{n+\frac{1}{2}}_{j+\frac{1}{2}} + \lambda^{n+\frac{1}{2}}_{j-\frac{1}{2}}}$$

$$\cdot\left\{\left(\overset{(2)}{\sigma}{}^{n+\frac{1}{2}}_{j+\frac{1}{2}} - \overset{(2)}{\sigma}{}^{n+\frac{1}{2}}_{j-\frac{1}{2}}\right) - \frac{\overset{(2)}{\sigma}{}^{n+\frac{1}{2}}_{j+\frac{1}{2}} + \overset{(2)}{\sigma}{}^{n+\frac{1}{2}}_{j+\frac{1}{2}}}{\overset{(2)}{n}{}^{n+\frac{1}{2}}_{j-\frac{1}{2}} + \overset{(2)}{n}{}^{n+\frac{1}{2}}_{j-\frac{1}{2}}}\cdot\left(\overset{(2)}{n}{}^{n+\frac{1}{2}}_{j+\frac{1}{2}} - \overset{(2)}{n}{}^{n+\frac{1}{2}}_{j-\frac{1}{2}}\right)\right\}$$

The stresses $\overset{(1)}{\sigma}$ and $\overset{(2)}{\sigma}$ are evaluated by substituting corresponding values of λ and γ in the appropriate constitutive relations.

Velocity Boundary Conditions:

At Z = 0 (j = 1), the velocities $\bar{v}_j^{n+1}$ and $\bar{w}_j^{n+1}$ are specified.

$$\bar{v}_1^{n+1} = \bar{w}_1^{n+1} = \bar{v}(\tau)$$

To evaluate λ_1^{n+1}, γ_1^{n+1}, it is necessary to employ implicit difference equations. These are obtained by centering at $(1\frac{1}{2},\ n+\frac{1}{2})$. Thus

$$\lambda_1^{n+1} = \lambda_2^n + \lambda_1^n - \lambda_2^{n+1} + \frac{\Delta\tau}{\Delta Z}\left(\bar{v}_2^{n+1} + \bar{v}_2^n - \bar{v}_1^n - \bar{v}_1^{n+1}\right),$$

$$\gamma_1^{n+1}\left(1 - a_1\frac{\Delta\tau}{\Delta Z} - b_1\frac{\Delta\tau}{\Delta Z}\right) = b_1\frac{\Delta\tau}{\Delta Z}\left(\gamma_2^{n+1} + \gamma_2^n + \gamma_1^n\right)$$

$$- a_1\frac{\Delta\tau}{\Delta Z}\left(\gamma_2^{n+1} + \gamma_2^n - \gamma_1^n\right) - \gamma_2^{n+1} + \gamma_2^n + \gamma_1^n ,$$

where

$$a_1 = \frac{\left(\bar{w}_2^{n+1} + \bar{w}_2^n + \bar{w}_1^{n+1} + \bar{w}_1^n\right) - \left(\bar{v}_2^{n+1} + \bar{v}_2^n + \bar{v}_1^{n+1} + \bar{v}_1^n\right)}{\lambda_2^{n+1} + \lambda_2^n + \lambda_1^{n+1} + \lambda_1^n},$$

and

$$b_1 = \frac{\bar{w}_2^{n+1} + \bar{w}_2^n - \bar{w}_1^n - \bar{w}_1^{n+1}}{\lambda_2^{n+1} + \lambda_2^n + \lambda_1^{n+1} + \lambda_1^n} .$$

Recently, the POROUS code has been modified to apply the velocity boundary condition at $j = 1\frac{1}{2}$. In this case, $\lambda_{1\frac{1}{2}}^{n+\frac{1}{2}}$, $\gamma_{1\frac{1}{2}}^{n+\frac{1}{2}}$ may be directly evaluated from the regular difference equations at $(j+\frac{1}{2},\ n+\frac{1}{2})$. Value of f_1^n is approximated by $2f_2^n - f_3^n$.

Artificial Viscosity:

In order to smooth out the shocks, a simple qudratic artificial viscosity term was added to the partial pressures.

$$\overset{(1)}{q}{}^{n+\frac{1}{2}}_{j+\frac{1}{2}} \approx \overset{(1)}{q}{}^{n}_{j+\frac{1}{2}} = \frac{2a^2}{\lambda^n_j + \lambda^n_{j+1}} \left(\bar{v}^n_{j+1} - \bar{v}^n_j\right)^2 ,$$

$$\overset{(2)}{q}{}^{n+\frac{1}{2}}_{j+\frac{1}{2}} \approx \overset{(2)}{q}{}^{n}_{j+\frac{1}{2}} = \frac{2a^2 \overset{(2)}{\rho}_0}{\overset{(1)}{\rho}_0 \left(\gamma^n_j + \gamma^n_{j+1}\right)} \left(\bar{w}^n_{j+1} - \bar{w}^n_j\right)^2 .$$

$$\overset{(1)}{q}{}^{n}_{j} = \frac{a^2}{4\lambda^n_j} \left(\bar{v}^n_{j+1} - \bar{v}^n_{j-1}\right)^2 ,$$

$$\overset{(2)}{q}{}^{n}_{j} = \frac{a^2 \overset{(2)}{\rho}_0}{4 \overset{(1)}{\rho}_0 \gamma^n_j} \left(\bar{w}^n_{j+1} - \bar{w}^n_{j-1}\right)^2 .$$

The artificial viscosity term $\overset{(1)}{q} \left(\overset{(2)}{q}\right)$ is evaluated only when $\partial\bar{v}/\partial Z (\partial\bar{w}/\partial Z) < 0$. For $\partial\bar{v}/\partial Z (\partial\bar{w}/\partial Z) \geq 0$, it is set equal to zero. The coefficient "a" (when used) is taken to be 2.

NATIONAL TRANSPORTATION SAFETY BOARD
Washington, D. C. 20591

SA-None File No. A-0003

AIRCRAFT ACCIDENT REPORT

ALITALIA AIRLINES
MCDONNELL-DOUGLAS DC-8-62, I-DIWZ
(ITALIAN REGISTRY)
JOHN F. KENNEDY INTERNATIONAL AIRPORT
JAMAICA, NEW YORK
SEPTEMBER 15, 1970

Adopted: APRIL 28, 1971

ERRATA

The following changes should be made to the subject report:

Page 10, column 1, lines 10 - 12 delete "at a point approximately 0.1 mile before reaching the outer marker (approximately 2.9 miles from the end of the runway)." and insert: "at a point approximately 2.8 miles from the end of the runway."

Page 11, column 2, (b) Probable Cause, Line 6 insert: "high" following ". . . uncorrectable".

REPORT NUMBER: NTSB AAR-71-9

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